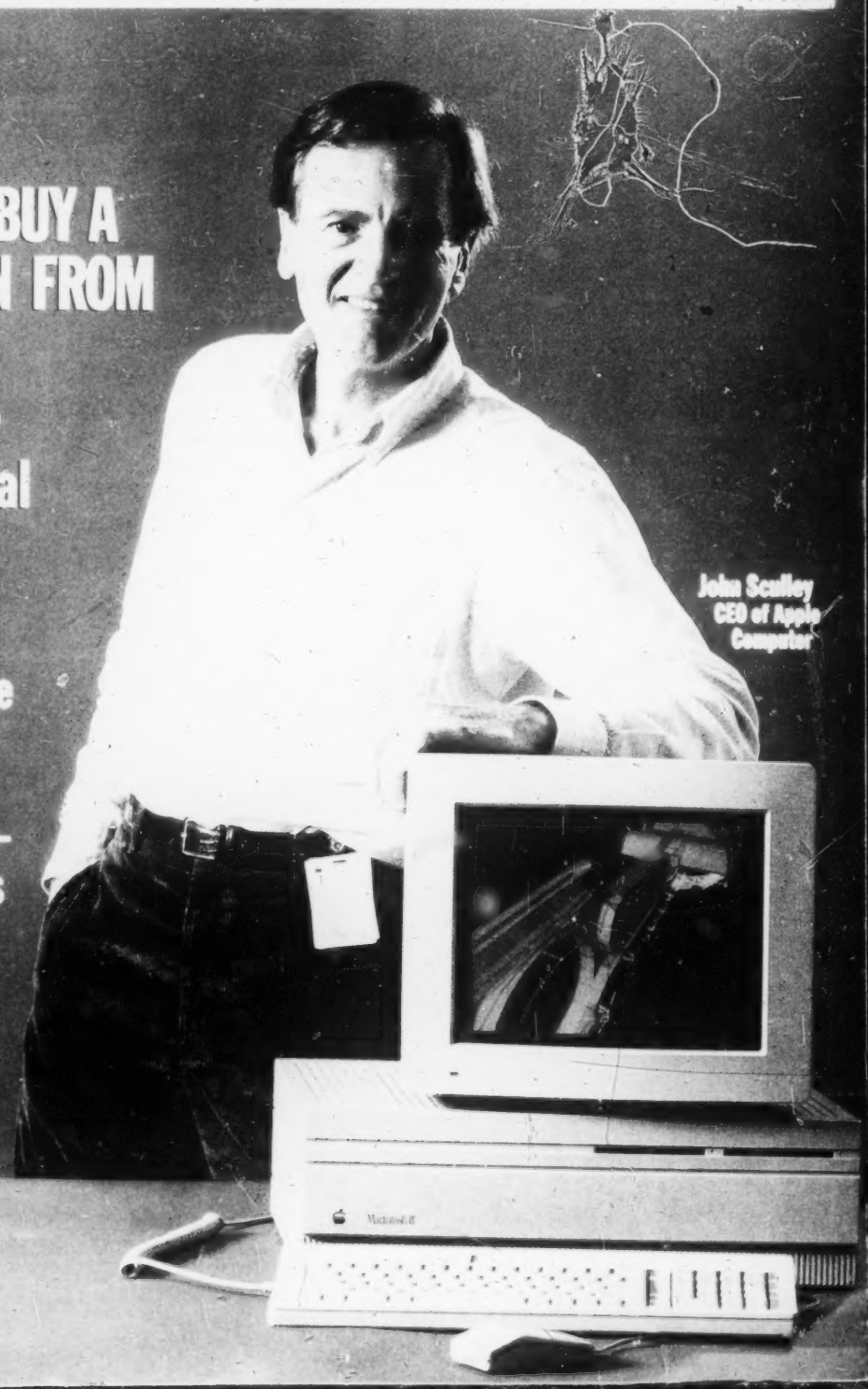
SIX DOLLARS

A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS/COMPUTER & SYSTEMS COMPANIES—WORLDWIDE

MAY 15, 1988



WOULD YOU BUY A WORKSTATION FROM THIS MAN?

Apple's bid for engineer appeal
PAGE 24

America's mixed messages on trade laws PAGE 14

Top IC production-equipment makers
PAGE 100

John Sculley
CEO of Apple Computer

Electronic Business

AGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 14, NO. 10 MAY 15, 1988

PAGE 24 Macintosh man John Sculley

COVER STORY/STRATEGIES

WORKSTATIONS

24 Would you buy a workstation from this man?

Apple CEO John Sculley has his eye on the engineering workstation market—which he figures will be worth $1 billion to his company in the 1990s. Sculley expects to trade on the fanatical devotion of Apple Macintosh users and launch the under-$10,000 workstation market. But the Mac II still lacks much in the way of engineering software.

BUSINESS TRENDS

TRADE

14 How America has been sending out mixed messages on trade

Forget the tough talk about locking out foreign rivals—new trade rules won't be that firm. A bickering electronics industry is partly to blame for that.

CAPITAL EQUIPMENT

16 Perkin-Elmer cashes in on superconductivity

The market for superconductive materials is still in its infancy, but that has not deterred the IC production gear firm.

POLITICAL AFFAIRS

18 The electronics chiefs put the moves on Washington

Electronics execs say it's easier than ever to get pols to listen to trade talk. But then, it is an election year.

COVER STORY/STRATEGIES

WORKSTATIONS

24 Would you buy a workstation from this man?

Apple's souped-up Mac II sure looks like a workstation. But what's missing is third-party software.

FINANCE

VENTURE CAPITAL

36 A wild bear-back ride for electronics financiers

Seven months after "Black Monday," electronics firms are finding it's still expensive to raise cash.

DIRECTORY OF VENTURE CAPITAL FIRMS

40 Who's who in venture capital

Annual directory of venture capitalists that best serve the electronics industry.

ASIA BUSINESS

PERSONAL COMPUTERS

56 The PC market in Japan: Where's IBM?

In a crowded field of competitors, IBM has failed to wow the Japanese PC market. Will the PS/2 make a difference?

SEMICONDUCTORS

60 Motorola stalks the Hong Kong ASIC market

Amid widespread skepticism, Motorola is investing more than $200 million in Hong Kong's ASIC market. Will the gamble pay off?

COMPUTER BUSINESS

CIM

68 Unisys' CIM hits midsized customers with room to grow

It's preaching Unix and OSI, but Unisys still must practice proprietary hardware and software. Is that enough to shake IBM's and DEC's CIM grip?

BOARDS

72 PC fax: The phone is ringing but will anyone answer?

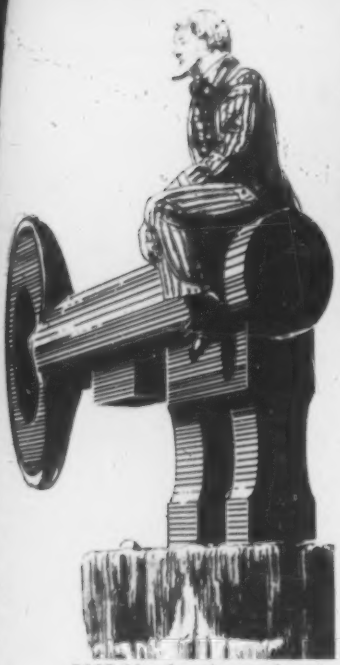
Egged on by sales of fax machines, sales of PC fax boards are expected to skyrocket. Suppliers, though, are skeptical.

DISK DRIVES

76 Rigid-drive media makers spur production spending

Makers of thin-film disks are spending big to keep up with disk-drive firms' demands. The trick is in how big to spend, which calls for smart forecasting.

Cover photo: Liane Enkelis

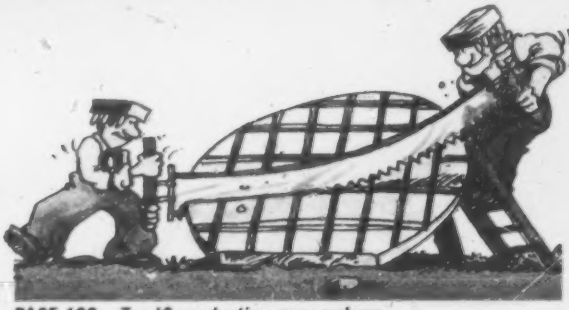


PAGE 14 America sends out mixed messages on trade

PAGE 68 Unisys' bid to strike it big in CIM

PAGE 36 Wild ride for electronics financiers

PAGE 56 Where's IBM? The PC market in Japan



PAGE 100 Top IC production-gear makers

TAPE DRIVES

82 Compatible makers push 3480 tape drives downward

Compatible tape drive makers are giving IBM competition in the high end. Now they may migrate 3480s to the midrange.

BOARDS

88 Edging into an OEM supermini market

Edge Computer might be a small fish in a big pond, but the supermini maker is attracting a lot of attention.

MODEMS

92 High-speed modem madness: In search of standards

Data compression, a technique which can double or triple a modem's speed, is changing the face of the 9,600 bps segment.

Market Perspectives

SEMICONDUCTOR PRODUCTION EQUIPMENT

100 IC equipment vendors wise up to economic reality

They must. There are still far too many of them, and IC makers are pruning supplier lists. So the gear firms are going back to what they do best.

SEMICONDUCTORS

108 Broadcast bulletin: ITT and Philips see cash in TV chips

Direct broadcast by satellite TV is nearing reality in Europe. Chip makers sense big sales in ICs for decoder boxes—if the next DBS satellite works.

CONSUMER ELECTRONICS

112 The picture sharpens for U.S. cable equipment vendors

As the cable television industry penetrates more households, demand for converters and other gear intensifies.

Business Barometer

FORECASTS AND INDEXES

141 **Computers**
Computer companies are back to their growing ways

142 **Active components**
Producer price indexes

144 **Plant utilization**
Electrical machinery, instruments and aerospace

146 **Computer market database**
New orders and shipments

Departments

5 **Inside Business**

9 **Letters**

11 **Upstarts**
Integrated Silicon Systems, Vantage Analysis Systems and Gazelle Microcircuits

124 **Plant Sites: Singapore**

130 **Comment**
The ascendancy of high-tech marketing

134 **Coming attractions**

137 **My View**
A world without salespeople

138 **Management calendar**
Advertiser index

148 **Viewpoint**
Catch the opportunity in the discontinuity

COMPANIES IN THIS ISSUE

138 **An index of the 119 companies covered in this issue.**

EDITORIAL STAFF

Publisher: Frank J. Burge

Associate Publisher and Editorial Director: Alberto Socolovsky

Editor: Allen Furst

Managing Editor: John Kerr

Managing Editor/Special Projects: Norman Alster

Senior Editors: David Card, Alden M. Hayashi, Linda Stallmann, Anne Knowles

Associate Editors: Jack Gee, Beth Karlin Bruce C. P. Rayner, Valerie Rice

Assistant Editor: Mary Donovan

Copy Editor: Barbara Jorgensen

Editorial Assistant: Sherri Hartlen

Contributing Editors: Stephen Gross (Minneapolis), Shohei Kurita (Tokyo), Michael Leibowitz (Boston), Philip Liu (Taiwan), Tom McCusker (Los Angeles), Lin Sun (Boston), Elizabeth Baatz (Cahners Economics), Madeline Franchi (Cahners Economics)

Managing Editor Production: Roger C. Plant

Production Editor: C.J. Korisky

Assistant Production Editor: Linda S. Cohen

ART STAFF

Art Director: Bill Cooke

Staff Artist: Christina Rutter

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, Mass. 02158 (617) 964-3030 Telex 94 0573 CPC BSN 6502502256 MCI Fax 617-964-5490

Washington, D.C.: Beth Karlin
1333 F Street NW, Suite 720
Washington, D.C. 20004 (202) 628-2773

San Jose, Calif.: Valerie Rice
Sherman Building, 3031 Tisch Way, Suite 100, San Jose, Calif. 95128 (408) 296-0868

Irvine, Calif.: Bruce C. P. Rayner
18818 Teller Avenue, Suite 170
Irvine, Calif. 92715 (714) 851-9422

Northwest: Paula Doe
5011 133rd Place SE
Bellevue, Wash. 98006 (206) 641-0903

Paris: Jack Gee
11, rue de Vaugirard, 75006, Paris, France
011-331-4-354-4200 Telex: 21 4235

PRODUCTION

VP Production: Wayne Hulitzky

Director of Production/Manufacturing: John R. Sanders

Production Supervisor: Bill Tomaselli

Production Manager: Betsy Harkins (617) 964-3030

CIRCULATION

Group Circulation Manager: Sherri Gronli

Circulation Manager: Eric Schmierer
271 St. Paul Street, Denver, Colo. 80206
(303) 388-4511

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices. Contact Joanne Westphal, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, Ill. 60018 (312) 635-8800
Total Circulation: 76,550

A peek into the future

It is practically a truism: as computer hardware gets cheaper, faster and more cost effective, the market takes on a kind of commodity character. First, there's a flood of vendors; then a shakeout; finally, only those with deep pockets and manufacturing capability survive.

From the point of the customer, machines become almost interchangeable; software becomes the distinguishing factor; vendors scramble to seize existing distribution channels; and price becomes the overriding feature in the marketplace.

Well, we haven't quite reached that stage yet in workstations . . . but we're awfully close. When a company like Apple — which spent more money last year on public relations and advertising than it did on R&D — unveils an under-$10,000 workstation, we can see the handwriting on the wall. One day, workstations will be as user friendly and prevalent as personal computers.

Don't be misled. We are *not* saying we have seen the future of workstations and it is Apple. But we *are* saying that we have seen the future of Apple and it is workstations.

I strongly urge you to check out our cover story by senior editor Dave Card on where CEO John Sculley is taking Apple in the years ahead. The implications of the Apple story are of consequence to the entire industry. If Sculley — and competitors like Sun Microsystems — can turn a workstation into a commodity item, can supercomputers be far behind?

Adventures in venture

Also in this issue is our once-a-year ranking of the top venture capitalists in the electronics community. To our knowledge, this is the only such list of its kind. We're not particularly interested in providing data on venture capitalists that sink their money into biotechnology or other forms of investment. Our mission is to provide you, our readers, with information about venture capitalists who are oriented toward investment in electronics.

David Card

We believe this list, which was compiled by assistant editor Mary Donovan, will be especially useful to start-ups, as well as to the management of small- and medium-sized companies seeking mezzanine financing. And accompanying our list is, we believe, an insightful article by associate editor Bruce Rayner on the perils of going public. Good reading.

AL FURST
Editor

ELECTRONIC BUSINESS® (ISSN 0163-6197) is published semi-monthly, except monthly in December, by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President, Frank Sibley, Group Vice President, Jerry D. Neth, Vice President/Publishing Operations, J.J. Walsh, Financial Vice President/Magazine Division, Thomas J. Dellamaria, Vice President/Production and Manufacturing. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5191. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5191 and additional mailing offices. POSTMASTER: Send address corrections to ELECTRONIC BUSINESS® at the Denver address. ELECTRONIC BUSINESS® copyright 1988 by Reed Publishing USA. Saul Goldweitz, Chairman, Ronald G. Segel, President/C.E.O.; Robert L. Krakoff, Executive Vice President; William M. Platt, Senior Vice President. Annual subscription rates for non-qualified people: USA/Canada/Mexico, $55 per year; other countries, $85 per year (including air freight); $170 per year for air mail. Except for special issues where price changes are indicated, single copies of regular issues are available for $6.00, $8.00 and $10.00 (USA; Canada/Mexico and foreign). Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5191. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Manufacturing • Foodservice & Lodging • Electronics & Computers • Interior Design • Printing • Publishing • Industrial Research & Technology • Health Care • Entertainment. Specialized Consumer Magazines: American Baby • Modern Bride

VBPA ABP

Would you buy a workstation from this man?

Apple CEO John Sculley wants you to view his souped-up Macintosh II as a low-end workstation too. It looks like one, but it lacks third-party software

BY DAVID CARD

Step right up! *Pree-senting:* the under-$10,000 workstation! Now all engineers can be automated! New markets opened! Affordable artificial intelligence! As an added bonus — or is it a catch? — the machine comes from Apple Computer Inc.

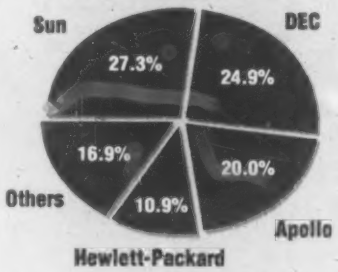
Whether Apple's entree into engineering workstations is bane or boon depends on the degree of your Apple-addiction. Apple hopes to carry the fanatical customer loyalty for its Macintosh personal computer into the workstation market via the souped-up Mac II and a new Technical Markets organization. Time, software and distribution will tell.

"We are in the process now of launching what we think may end up being the single highest growth area for Apple Computer over the next five years — what we call Technical Markets," says Apple chairman, president and chief executive, John Sculley. "[We] helped shape a market with desktop publishing, we think that we can help shape a market with the under $10,000 workstation for engineering," Sculley told ELECTRONIC BUSINESS in a recent interview at his firm's headquarters in Cupertino, Calif. The former Pepsi-Cola Co. president is counting on $1 billion worth of technical business for Apple in the early 1990s.

Introduced in March of 1987, 30 days before IBM first showed its Personal System/2 family, the Mac II sold to the tune of 75,000 units last year. That includes 10,000 units sold into technical applications, according to International Data Corp., a Framingham, Mass., market research firm. IDC analyst Vicki Brown expects Apple to sell 150,000 units this year, 40,000 of which will be used as technical workstations. Brown says the Mac II impact on the workstation market "is going to be huge." She adds that even though Apple "may never get over 10% of the units in technical workstations, that's a lot."

U.S. workstation market

Share of worldwide sales by U.S. vendors



Total 1987 market: $2.76 billion

Source: International Data Corp.

This is the party Apple wants to crash

In part, Sculley is hoping Apple will be able to trade on the increasing popularity of the Mac among a wide range of personal computer users. "What engineers have to have, perhaps even more than raw compute power, is that they have to be able to do personal productivity-type functions as well," Sculley observes. "We bring with us the wealth of all that software base that we have on the Macintosh."

In fact, to a large extent, Apple is a brand name among engineers. Peter Hamilton, general manager of the marketing division for Hewlett-Packard Co.'s Technical Computer group, says that HP, in gathering competitive data, estimates that a third of the PCs installed in the country's engineering departments already come from Apple. "A number of our own engineering/scientific customers have made sizable investments" in Apple computers, he adds.

Chasing the Sun

IDC says U.S. suppliers sold $2.8 billion worth of workstations worldwide last year, with leader Sun Microsystems Inc. accounting for $754 million of the total. Yet Apple shipped more Mac IIs than Sun's entire six-year installed base. No. 2 on IDC's list? Digital Equipment Corp., which just so happens to have a joint-development agreement with Apple. The two agree they will be "friendly competitors," but the friendship may be strained vying for desk space in the engineering departments of the

Larry Ewing

world. [See related story.]

As usual, distinctions are blurring between computer classes, but IDC defines technical workstations by their "multitasking" operating systems, which allow multiple application programs to run simultaneously. These machines are also predominantly sold direct as well as through value-added resellers or original equipment manufacturers.

However, Apple still sells its multitasking machines, including a Unix version, primarily through dealers. To date, it has qualified some 900 of its 2,000 regular dealers to sell the Mac II. Apple also has a direct salesforce that calls on about 75 big clients. But using dealers to sell workstations is a lot more difficult than using them to penetrate the home and office market — because workstations require a lot of support. Summit Strategies, a Boston consultancy, estimates that fewer than 100 of its dealers are capable of supporting workstations.

Lofty goals

However, Michael Homer, who heads up Technical Markets for Apple, is counting on informal partnerships with Apple-compatible hardware and software vendors to give added weight to Apple's engineering presence. At Apple's suggestion, for example, National Instruments — an Apple board maker — uses Apple's name to get into three of Sculley's biggest accounts: Boeing Co., E.I. du Pont de Nemours and Co. and Lockheed Corp. In time, Homer believes, the presence of third-party engineering software to run on the Mac II will help catapult Apple into the No. 1 or No. 2 spot in the under-$10,000 class of the following workstation markets: artificial intelligence; computer-aided design; manufacturing; scientific research; and software engineering.

Michael Homer, Apple's head of Technical Markets, won't pay software firms to port programs over to the Mac II

Homer thinks his competition will come largely from the new PCs based on Intel Corp.'s 32-bit 80386 chip and from the low end of the workstation suppliers' lines. Most workstations, including the Mac II, are powered by Motorola Inc.'s 32-bit 68020 chip. But before Apple can make any inroads in the $2.7 billion U.S. workstation market, it must contend with leaders like Sun, which already has some under-$10,000, 68020-based workstations, and is bringing out a 386-based model as well.

In addition, Apple may also have to go head-to-head with its old PC nemesis in the office market — IBM. Big Blue — although it now only has about $100 million in workstation sales, making it the sixth-largest U.S. supplier — believes it can be a bigger force in the engineering market through its PS/2 family and RT PC workstation. But, Sculley says, for the time being, he isn't very worried about either IBM or its clones — thanks, in large part, to IBM's decision to switch from its old operating system on the IBM PC, DOS, to a newer and largely incompatible operating system, OS/2.

"The DOS world is going through a massive transition," Sculley says. "My sense is that the transition is going to take considerably longer than most people have speculated, because of the large investment [in DOS] that already exists."

Sculley may be underestimating the OS/2 momentum, but he has the marketing bag of tricks to make the most of Apple's customer loyalty. At Pepsi, Sculley headed up the "Pepsi Challenge," and outfoxed Coke by inventing the 12-pack and the 32-ounce bottle. "Nullify a competitor's strength by changing the ground rules," Sculley wrote in his autobiography-cum-management textbook, *Odyssey*. He also wrote, "Marketing is, after all, theater." Consequently, Apple spent more on advertising than on R&D by a margin of over two-to-one when launching the original Macintosh, although Sculley now admits that was a mistake. Even so, for fiscal 1987, Apple spent $222 million overall on advertising and public relations, versus $192 million on R&D across its entire product line.

But no matter how much Apple invests in the Mac II, it's clear that the machine, in order to be successful, must also find third-party software

Lane Erickson

Here comes Digitapple?

When Kenneth Olson, Digital Equipment Corp.'s CEO, announced a joint development agreement with Apple Computer Inc. in January, he said it was something he and Apple CEO John Sculley had been talking about over the course of four Maine vacations. So far, however, the joint effort has yet to yield tangible results.

In fact, many third-party software vendors and competitors are skeptical that the DEC/Apple alliance really means anything at all. "It's really positioning, more than anything else. Do you think you'll ever see a product out of it?" asks David Saykally, president of software maker Unify Corp. Peter Hamilton, a marketing exec for Hewlett-Packard Co., calls it "a marriage of convenience because DEC doesn't have a PC strategy."

And, in terms of workstations, it's doubtful that the alliance will ever produce a joint product or marketing arrangement. DEC has its own very successful workstation, the VAXstation family. And as VAXstation prices drop, "they are starting to compete with PCs," concedes DEC's vice president of Business and Office Information Systems, Henry Ancona.

So for the time being, says DEC vice president Dominic LaCava, Digital and Apple will engage in a little "friendly competition" for the engineer's desktop. Asked if that is where DEC will compete most with Apple, LaCava replies: "I think the customers will determine that." □

vendors who want to write scientific and engineering programs for it. At Motorola, for example, Martin Kalfus, a senior design engineer in Phoenix, uses his Mac II for CAD, designing the packages for transistors and zener diodes with software from Micro CAD/CAM Inc. And down the hall, Zohar Raz, a systems engineer for Motorola's World Marketing group, does circuit board layout on his Mac. But the two, although loyal Mac fans, point out areas that Apple will have to work on before it wins any workstation wars.

Needed: smooth software

First, they say, Apple will have to attract some sophisticated software. Raz admits that the boards he designs are small, with "not such intensive requirements." And he uses his Mac mostly for doing presentation work. "It's not true engineering," he says, "but it's kind of helpful. There would be no other way to do it." He says the heavy-duty design engineering is done on Apollo Computer Inc. workstations with software from Mentor Graphics Inc. "The software support [for the Mac II] was a lot slower than I had hoped," adds Kalfus. "Probably because it's much more difficult to write programs for it."

Other Mac customers paint much the same picture. "We have them in engineering, but we use them for product scheduling," says Lawrence Lunetta, a vice president at Ridge Computers. And James Clark, chairman of Silicon Graphics Inc., which also makes workstations, says: "I have one in my office and one at home. I use them for what everybody else uses them for — as word-processing systems."

Others, like Charles Foundyller, president of Cambridge, Mass., market research firm Daratech Inc., chide Apple for being too protective of its technology — making it difficult for Apple-compatible computer makers to enter the market. Until that happens, he says, there won't be a lot of engineering software available to run on Apple's operating system. "Apple's guarding the Mac like Pepsi guards its formula. It's the syrup-formula mentality," he says. (Apple filed suit in federal court in March, charging Hewlett-Packard and Microsoft Corp. with infringing on copyrights involving the Mac user

Dueling CEOs

In its quest to capture the engineer's desktop, Apple Computer Inc. is on a collision course with Sun Microsystems Inc., the workstation leader. And don't think Sun doesn't have its eye on the PC market, as well.

Sun originally based all its workstations on the same chip Apple now uses. But Sun is now attempting to set a Unix standard with its "Sparc" RISC chip. Sun will license Sparc to anybody, even rival computer companies. The idea is that software companies will then have an easier time writing software for the broadest number of computers.

ELECTRONIC BUSINESS *recently interviewed both Apple CEO John Sculley and Sun CEO Scott McNealy. Apparently, there's little love lost between the two companies.*

Michael Witte

JOHN SCULLEY	SCOTT McNEALY
On the low end	
"[The under-$10,000 workstation market is] going to require that you have more than just a cut-down version of the larger machine." (JS)	"[To get to the low end of the workstation market], all we have to do is drop down in cost, which means riding the experience curve down. We have gravity working for us. We're rolling downhill. [Apple is] pushing stuff uphill. (SM)
On distribution	
"The under-$10,000 market is going to require resellers, and we understand the reseller structure. A direct sale is just going to be too expensive." (JS)	"[Apple] just doesn't have a direct sales channel. And to create one just really challenges the dealers. Whereas if we were to try and create a dealer channel, we won't disappoint them. They already know what they're getting into." (SM)
On computer technology	
"Sun is a very successful company that is starting to fragment its efforts across a number of different architectures." (JS)	"[Apple] has to go through a major technology discontinuity to get to workstations and servers, which means a new operating system, a new CPU architecture, etc. Sun has already stepped through."(SM)

interface.)

However, Apple has never been one to let clone makers climb into its market. Apple built its $2.7 billion, *Fortune* 200 company in a hurry, by keeping ahead of the IBM pack. And the absence of clones has also kept Apple largely immune to price wars and its gross margins above 50%.

In addition, deviating from the pack can also sometimes help business. Apple, for example, recently chose the MIT-designed NuBus as its data pathway, instead of the workstation-standard VMEbus. Sculley says NuBus gives the same performance but is cheaper than VMEbus. And VMEbus is used by at least one other significant player: Texas Instruments Inc. TI and Apple are now co-labeling a Mac II with TI's AI chip inside.

Software, software, software

Still, the Mac II faces a lack of third-party engineering software. Not to worry, Sculley insists — it's coming. "Apple is going to be a significant enough player in this market," Sculley says, "that we will see some very significant products being brought over to the Macintosh platform, just as we've seen some very significant products brought over to the Macintosh platform in the business market in the last year." Adds Homer: "The way you acquire software is to ship systems."

If this approach seem passive, don't be misled. Apple has spent considerable effort on its software, specifically its operating system. Sculley says the constant rewriting of the Mac operating system, while still maintaining compatibilty with earlier versions, is the biggest project Apple has going. There's a $15.5 million Cray Research Inc. supercomputer in Apple's labs that is used to simulate the performance of operating systems, software and new hardware.

In '87, Apple shipped more Mac IIs than Sun's entire installed base

Apple also spent a little over $10 million to adapt Unix, with the help of British software company UniSoft Corp. Apple has done some very clever things with its version of Unix, which it calls "A/UX." For one thing, A/UX retains the famous Mac graphic interface. Sculley says it is the first friendly Unix, and Mac fanatics everywhere applaud. Plus, Apple has built some hooks into A/UX so that if a software developer writes an application program for A/UX, that program only needs to be tweaked to get it running under the Mac operating system. The process also works both ways — Mac operating system programs can theoretically move easily to A/UX. That should encourage developers to take advantage of the installed Mac base. The PC-based CAD leader, Autodesk Inc., just joined the Apple camp, and is working on a more "Macintoshy" version for the future.

Apple won't pay software companies to port programs over to the Mac II — "I don't particularly believe in bribery," Homer says — but it does loan out development equipment and has a staff of 15 software experts to help out developers with code writing.

Distributing the wealth

Another key area Apple has to work on is tuning up its distribution channels. Right now, the rival workstation companies are cultivating new channels of distribution, especially VARs. As the price of workstations slides, making direct sales has become too costly. [See ELECTRONIC BUSINESS March 15, 1988 p64].Here, Apple's established dealer network and its 200 VARs are a plus. Joseph Roebuck, sales vice president for Sun and an ex-Apple employee, admits as much. When asked which company will hound him most in competing for the new channels, Roebuck answers: "I have to assume it's probably Apple for the Mac II. I think they are the primary competition."

But the third-party channels are only beginning to warm to Apple engineering. At National CADD-Pro Inc., a big consortium of engineering VAR/dealers that handles PCs and workstations, members are only just starting to look at the Mac II, according to president Gordon Medlock. Adds Dana Dotson, marketing manager for Douglas Electronics, which sells circuit board design software for the Mac: "It's kind of hard to find Apple VARs."

But Sculley is confident that Apple will get the software it needs to fire up its VARs. Engineering is no backdoor entrance to corporate America for Apple; it is serious business. "Apple doesn't really need to go through the back door anymore, we're walking through the front door," Sculley says. "Engineering is a large enough market by itself to stand on its own. We see a billion-dollar business out there for Apple in the early 1990s, and consequently it's not the back door to anything." □

Can Mac II make it in the CAE world?

The leading computer-aided engineering companies have seen Apple Computer Inc.'s Macintosh II workstation, but so far, they're not impressed. The director of Apple's Technical Markets group, Michael Homer, admits that workstation "requirements are a little bit stiffer," in electronics design. None of the leading CAE players are interested in writing software for the Mac II; all claim to see no demand for it from their customers.

"We've got our hands full with two platforms," says W. Douglas Hajjar, president of Valid Logic Systems Inc. which resells workstations from Digital Equipment Corp. and Sun Microsystems Inc. "Mentor believes in Apollo. Daisy seems to be going with the Sun '386. The three major players are locked up," Hajjar says. "People won't look at Apple unless the box is so great that engineers begin pushing it."

But Andrew Rappaport, president of Boston consultancy The Technology Research Group, thinks that the PC-based CAE companies should jump on the Mac II. Most of those companies are now making the transition to workstations, he says, and might think that Apple was only halfway there. They should think again: "A lot of people want to buy the Mac II rather than a Sun," Rappaport says. "The first viable package on the Mac II is going to do *extremely* well." □

A wild bear-back ride for electronics financiers

Seven months after "Black Monday," electronics firms are finding it's still expensive to raise cash

BY BRUCE C.P. RAYNER

By the end of the day, Joe Costello's worst fears had been realized. Costello, president and chief operating officer of San Jose-based SDA Systems Inc., was planning an initial public offering (IPO) for his firm.

However, the day in question was October 19, 1987 — one of the worst days in the history of Wall Street. And, along with a record 508-point drop in the Dow Jones industrial average, a year's worth of planning and preparation at SDA Systems was instantly erased. Six months later, on February 25, the company, which develops computer-aided design software for chips, announced its intention to merge with ECAD Inc., a Santa Clara, California-based public company in the same business. It was a good fit, but it was not an IPO.

It has not been all bad news, however, for start-up firms planning to go public. Down the road from SDA Systems, Octel Communications Inc. in Milpitas, Calif., also decided to postpone its IPO when the crash hit. But the voice-processing systems company bided its time, and five months later, it was in the vanguard of post-crash companies willing to test the public market waters. According to David Torrey, Octel's director of business development, the March public offering — which raised $16.9 million — was considered a success. Venture capitalists generally agree that Octel did fairly well, but the valuation was a far cry from what it could have achieved had it gone public prior to the crash.

At the same time, Black Monday has also left its mark on the venture capital community. Venture capitalists today remain uncertain as to the short-term future of their mature investments. Most pundits agree that there is little chance of a quick return to the kinds of high valuations common in the bull market that preceded October 19. However, there is some optimism that the market is improving. Jonathan Bayless, a general partner in the Dallas-based venture firm of Sevin Rosen Bayless Borovoy, expects the IPO market to be back within the next few months. Still, since the crash, there has only been a handful of IPOs, a far cry from the 80 in the first nine and a half months of 1987, as reported by Venture Economics Inc., a market research firm in Wellesley, Mass.

Traditionally, IPOs have been the most common method by which venture capitalists cash in on their investments. But now, companies are either postponing the decision to go

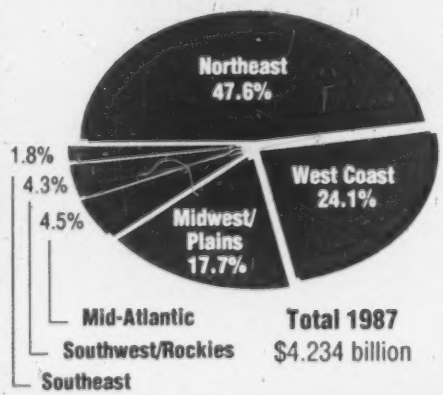
More money is chasing more ideas...

Private venture capital investment
($ billions)

Source: Venture Economics

...but only in some regions...

Regional distribution of capital commitments
(percentage of distribution)



Source: Venture Economics

...and only for some segments of electronics

Ranking of capital commitment preference in 1987
(percentage)

1. Software
2. Communications
3. Medical instrumentation
4. Computers
5. Semiconductors
6. Production equipment
7. Military electronics
8. Automatic test equipment

Source: ELECTRONIC BUSINESS

public or else searching out other more lucrative options. In a survey of venture capitalists conducted by ELECTRONIC BUSINESS earlier this year, almost 95% of the respondents believed the October crash would force companies to postpone decisions to raise equity capital. Similarly, 78% expected the number of strategic alliances, joint ventures, mergers and acquisitions to increase. (Of the 370 venture capitalists whom we queried by mail, a total of 59 responded — for a response rate of 16%.)

Later stage opportunities

From the venture capitalist's point of view, of course, there is no denying that good deals can be found in electronics — especially if the investors are willing to diversify into later stage companies. Even for second- and third-stage financings, venture capitalists have been able to get better prices on their investments as values have come down. There is, however, still a difference of opinion among venture capitalists as to whether values will come down even further. "Right now, the market looks better than it has for the last 18 months," insists Paul Hogan, president at BancBoston Ventures Inc.

There is more action in the leveraged buy outs (LBOs) market too, as both banks and venture capitalists look for ways to diversify their portfolios. While banks invest in LBOs as a way to generate cash flow through the sale of assets, venture capitalists are increasingly looking for growth-oriented LBOs. John Baker, vice president and general partner at Alan Patricof Associates Inc. in New York City, calls these companies "growth buy-outs." Instead of the traditional 10-to-1 ratio between debt and equity, Baker says he prefers to over-fund growth buy-outs with equity — at a ratio as high as 4-to-1, or even 2-to-1. In that way, if growth materializes, the return is good and the company can more manageably service its debt.

Unlike the LBO market, the mezzanine market — that stage of financing right before a company is taken public — is still pretty dry, says Bayless of Sevin Rosen Bayless Borovoy. The reason is that companies looking for mezzanine financing are holding out for pre-crash valuations. However, in most cases, institutional and venture capital investors are not willing to accomodate these companies.

For earlier stage deals, such as seed and start-up companies, venture capitalists remain bullish about the general health of the market. For the most part, it is these fledgling companies that are the bread and butter of the venture capitalists' business. Because most early stage investments can range between five and 15 years in duration, the state of the stock market and economy have less of an impact on their valuations.

According to our ELECTRONIC BUSINESS survey of 59 venture capitalists, 67% of those responding said they expect to increase their total investments in 1988. Considering that Venture Economics reports a record $4 billion increment in capital commitments to private venture funds in

Top 10 U.S. venture capitalists

1987 figures	Total investment in electronics ($ millions)	Electronics investment as a percentage of total	Average electronics investment per deal ($ millions)
TA Associates	$31.5	60%	$1.2
New Enterprise Associates	$28.4	54%	$0.6
Warburg Pincus Ventures	$26.0	7%	$2.8
Oak Investment Partners	$22.3	72%	$5.9
Raytheon Ventures	$22.0	88%	$2.7
Sequoia Capital	$21.4	69%	$1.0
Summit Ventures	$19.2	60%	$1.7
Menlo Ventures	$18.0	82%	$1.0
Merrill Lynch Venture Capital	$16.5	85%	$1.5
J.H. Whitney & Co.	$15.9	52%	$0.8

Source: ELECTRONIC BUSINESS

1987, there is every reason to believe that investments will indeed increase. However, only 11% of the venture capitalists surveyed characterize opportunities in the U.S. computer and electronics industry as "excellent." The majority believe electronics will perform a little better than average in the remainder of 1988. Still, 54% expect to increase their investments in electronics companies in 1988. Software ranks at the top of the list in terms of where the most start-up activity will occur in 1988 — with communications a close second.

Most venture capitalists also agree that high tech is not the darling of the venture capitalist that it was earlier in the decade. "Venture capitalists are taking a broader view of life now," admits Gary Stoltz, partner at Pathfinder Venture Capital Funds, a Minneapolis-based firm with funds totaling $73 million.

Shifting emphasis

Overcompetition and overcapacity in the computer and peripherals business have specifically turned a lot of venture capitalists away from hardware. And with many of the 1980-vintage electronics companies coming to market with new products this year, the options for start-ups look less sanguine. As a result, Stoltz says that Pathfinder's fund has shifted from 70% electronics in 1980 to just 40% today. Similar shifts are reported from other firms, with the emphasis moving toward biotechnology, medical instrumentation and services, as well as specialized retailing.

Stephen Gaal, a partner in the Boston-based venture capital firm of TA Associates, with funds between $400 million and $500 million, agrees that diversification of investments is more common. Still, TA Associates is focusing more on high-tech start-ups these days, says Gaal.

Traditionally, start-ups operate in more of a "narrow band" of valuations than do later stage companies, and now start-ups are valued at the lower end of that band, he says. Gaal is currently interested in optical disk technology and low-priced 32-bit workstations. As with other venture capitalists, software and networking are also high on his list of markets to watch.

The flow of deals in electronics is little changed from the pre-crash market, most venture capitalists say, but the jury is still out as to whether the quality is still up to snuff. "Operationally, we get as many deals through the door as we did before, and they seem to have the same characteristics," says David Gold, a general partner with Indosuez Ventures in Menlo Park, Calif., which is a subsidiary of Paris-based Banque Indosuez. Gold favors vertical market companies that focus on a niche by offering application-specific solutions built around other vendors' hardware and software.

But David Dunn, a managing partner with Idanta Partners in Fort Worth, Texas, chairman of Prime Computer Inc., and a 25-year veteran of the venture capital business, does not agree that high-tech business is easy to find. "I think it is harder to make good investments in the computer industry than it was 20 years ago because of shorter product life cycles. If you miss development time by one year now, you are out of business," he says. Still, Dunn remains bullish on electronics.

High tech is no longer the darling of the venture capitalist

As for where in the United States that money is being made, the most successful location for venture capitalists is still California. Richard Florida, assistant professor in the School of Urban and Public Affairs at Carnegie Mellon University, insists that California will continue to exert a strong magnetism for start-ups because the venture capital infrastructure is so well developed. More and more, East Coast venture capitalists will find it essential to set up a California office if they expect to compete, he says. Besides California, he also favors Minneapolis-St. Paul as a region to watch.

On the national level, the Tax Reform Act of 1986 continues to be a hotly debated issue among venture capitalists. While some insist that the increase in the capital gains tax rate from 20% to 28% has had an effect on their willingness to invest in start-ups, others contend that the tax consequences are largely inconsequential. "I think the issue of a loss of preferential treatment is a bit of a red herring," says venture capitalist Gold. "The fact of the matter is that it will have a negligible impact on the industry of venture capital."

Stoltz, at Pathfinder, insists that tax reform has had a depressing effect on his firm's start-up activity. Combining the strong stock market in 1987 with the higher capital gains rate left Pathfinder with 25% less in start-up activity, he says. Another issue that Stoltz finds discouraging is the change in the net operating loss (NOL) carry-forward as a result of the tax bill. As of last year, NOL carry-forwards could no longer be applied against the acquiring company's taxes to the same extent as before.

From a political perspective, the only presidential candidate to publicly state a willingnesss to reduce the capital gains tax has been Vice President George Bush. If elected, Bush says he will lower the rate to around 15%. This is in the range that would maximize tax revenue, some economists argue. However, very few venture capitalists are changing their investment plans because of the upcoming election. □

Who's who in venture capital

In a year when America's economy was quaking on a Wall Street fault line, most U.S. venture capitalists continued to invest in high technology — welcome news for electronics executives seeking funding for their fast-growing companies.

Recognizing that these executives need up-to-date information on the venture capital firms that are ready to provide that funding, ELECTRONIC BUSINESS has assembled its annual directory of the venture capitalists that best serve the electronics industry.

The following is a report card of financial data provided by the venture capital firms that responded to the ELECTRONIC BUSINESS survey. It includes for each firm the 1987 figures for their total paid-in capital, total investment and total number of deals.

MARY DONOVAN

1987 figures **Company** Contact, telephone	Address	**Total paid-in capital** ($ millions)	**Dollar investment** ($ millions) Total	Electronics	**Number of companies invested in** Total	Electronics	**Preferred stage of investment**
Advent International Corp. Tom Laller: (617) 574-8400	45 Milk Street, Boston, Mass. 02109	NA	NA	NA	NA	NA	NA
Albert-Berman Capital Corp. Marty Albert: (818) 889-5565	31308 Via Colinas, Suite 107, Westlake Village, Calif. 91362	NA	NA	NA	8	6	First, second, third or mezzanine
American Research & Development Jan Moran: (617) 423-7500	45 Milk Street, Boston, Mass. 02109	$62	$12	$5	18	8	Seed, first, second
Asset Management Co. Craig Taylor: (415) 494-7400	2275 East Bayshore Road, Palo Alto, Calif. 94303	$90	$9.8	$6.1	21	10	Seed, first
BancBoston Ventures Inc./BancBoston Capital Inc. Paul F. Hogan (Ventures): (617) 434-2442 Frederick M. Fritz (Capital): (617) 434-2442	100 Federal Street, Boston, Mass. 02110	$145	$67.3	$4.1	37	11	First, second, third or mezzanine, follow-on
Battery Ventures Richard Frisbie: (617) 367-1011	200 Portland Street, Boston, Mass. 02114	$35	$9	$9	8	8	First, second, third or mezzanine, follow-on
Bay Partners Chuck Hazel: (408) 725-2444	10600 North De Anza Boulevard, Cupertino, Calif. 95014	$105	$6	$6	9	9	Seed, first, second, follow-on
Berry Cash Southwest Partnership Berry Cash: (214) 329-7279	13355 Noel Road, Suite 1375, Dallas, Texas 75240	NA	NA	NA	NA	NA	NA
Brentwood Associates G. Bradford Jones: (213) 826-6581	11661 San Vicente Boulevard, Suite 707, Los Angeles, Calif. 90049	$294	$30.6	$11.7	33	17	No preference
Capital Relations Inc. Robert Cosgrove: (805) 379-0790	4055 East Thousand Oaks Boulevard, Suite 215, Westlake Village, Calif. 91362	$65	$10	$10	4	4	Seed, first
Charles River Ventures Richard M. Burnes: (617) 429-0477	67 Batterymarch Street, Boston, Mass. 02110	NA	$24.4	$8.1	23	14	No preference
Chatham Venture Corp. Euan Malcolmson: (617) 863-0970	450 Bedford Street, Lexington, Mass. 02173	$25	$2.3	$2.3	4	4	Seed, first
Charter Ventures A. Barr Dolan: (415) 325-6953	525 University Avenue, #1500, Palo Alto, Calif. 94301	NA	NA	NA	12	6	No preference
Citicorp Venture Capital Ltd. Thomas C. Darling: (212) 559-1127	153 East 53rd Street, 28th floor, New York, N.Y. 10043	$500	$200	$5	15	2	First, second

(Continued)

DIRECTORY OF VENTURE CAPITAL FIRMS

1987 figures

Company Contact, telephone	Address	Total paid-in capital ($ millions)	Dollar investment ($ millions)		Number of companies invested in		Preferred stage of investment
			Total	Electronics	Total	Electronics	
Cornerstone Ventures (formerly Rothschild Unterberg Towbin Ventures) J. Michael Gullard: (415) 854-2576	3000 Sand Hill Road, Building 3, Suite 260, Menlo Park, Calif. 94025	$0	$2.5	$0.4	5	1	First, second
Crosspoint Venture Partners John B. Mumford: (415) 964-0100	1951 Landings Drive, Mountain View, Calif. 94043	$65	$16	$14.5	17	14	Seed
Dajen Consulting Corp. Robert Cohen: (201) 947-4945	9 Lundy Lane, Larchmont, N.Y., 10538	NA	NA	NA	NA	NA	NA
Dougery, Jones & Wilder Jeanne M. Mitchell: (415) 968-4820	2003 Landings Drive, Mountain View, Calif. 94043	NA	NA	NA	NA	NA	NA
In Texas: A. Lawson Howard: (214) 960-0077	Three Lincoln Centre, 5420 LBJ Freeway, Suite 1600, Dallas, Texas 75240	$86.5	$16.2	$2.5	27	3	No preference
Eastech Management Company Inc. M. Shanahan: (617) 338-0200	One Liberty Square, Boston, Mass. 02109	$34.3	$2.3	$1.5	4	3	Seed, first, second
Euclid Partners Corp. Frederick Wilson: (212) 489-1770	50 Rockefeller Plaza, Suite 1022, New York, N.Y. 10020	$36	$2.3	$1.6	9	6	First, second
Fairfield Venture Partners E. E. Pettinelli: (203) 358-0255	1275 Summer Street, Stamford, Conn. 06905	$100	$11	$4.5	More than 20	More than 10	Seed, first, second
First Century Partners David S. Lobel: (212) 698-6108	1345 Avenue of the Americas, New York, N.Y. 10105	$121	$7	$3	6	3	No preference
Franc & Associates Paul Franc: (619) 729-9372	353 Tamarack #B, Carlsbad, Calif. 92008	NA	NA	NA	NA	NA	NA
Grace Ventures Corp. Robert E. Pedigo: (408) 725-0774	20300 Stevens Creek Boulvard, Suite 330, Cupertino, Calif. 95014	$64	$7	$4	19	13	Seed, first, second, follow-on
Hambro International Venture Fund Fran Janis: (212) 288-7778	17 East 71st Street, New York, N.Y. 10021	$150	$10.2	$6	15	10	Seed, first
Heritage Capital Corp. G. Kinsey Roper: (704) 334-2867	2095 Two First Union Center, Charlotte, N.C. 28282	NA	NA	NA	NA	NA	NA
Hill, Kirby & Washing John G. Hill: (303) 442-5151	885 Arapahoe Avenue, Boulder, Colo. 80302	$6	$5.7	$3.6	9	7	Seed, first, second
IAI Venture Capital Group Noel P. Rahn: (612) 371-7935	1100 Dain Tower, P.O. Box 357, Minneapolis, Minn. 55440	NA	$3.8	$2.2	10	4	No preference
Idanta Partners Dev Purkayastha: (817) 338-2020	201 Main Street, Suite 3200, Fort Worth, Texas 76102	NA	NA	NA	NA	NA	NA
Indosuez Technology Group David E. Gold: (415) 854-0587	3000 Sand Hill Road, Building 2, Suite 160, Menlo Park, Calif. 94025	None	$3.6	$1.4	16	9	No preference
Intersouth Partners Joe Velk: (919) 544-6473	P.O. Box 13546, Research Triangle Park, N.C. 27709	$6.5	$4.8	$2.5	10	5	No preference
Interwest Partners Chuck McMinn: (415) 854-8585	3000 Sand Hill Road, Bldg. 3, Suite 255, Menlo Park, Calif. 95025	$135	$16.4	$7	28	14	No preference
JAFCO America Ventures W.E. Shelander: (415) 854-0746	2180 Sand Hill Road, #320, Menlo Park, Calif. 94025	NA	$2	$1.5	3	2	First, second, third or mezzanine, follow-on

(Continued)

1987 figures

Company Contact, telephone	Address	Total paid-in capital ($ millions)	Dollar investment ($ millions)		Number of companies invested in		Preferred stage of investment
			Total	Electronics	Total	Electronics	
J.H. Whitney & Co. Edward Ryan: (212) 757-0500	630 Fifth Avenue, Room 30200, New York, N.Y. 10111	NA	$30.8	$16.0	34	20	No preference
Kimberly, Brunell & Lehmann Inc. David A. Shaw: (202) 833-9031	1025 Thomas Jefferson Street, Washington, D.C. 20007	$0.5	Over $1	Over $1	Over 5	Over 5	No preference
Kleiner Perkins Caufield Byers Dina Downey: (415) 421-3110	4 Embarcadero Center, Suite 3520, San Francisco, Calif. 94111	$42.5	$33.8	NA	33	26	Seed, first
The Lambda Funds/Drexel Burnham Lambert Inc. Alexandra Mahnken: (212) 480-6018	55 Broad Street, 15th floor, New York, N.Y. 10004	$40	$6.0	$4.1	15	10	Second, third or mezzanine, follow-on
Lawrence, Tyrrell, Ortale & Smith Brian Horey: (212) 826-9080	515 Madison Avenue, New York, N.Y. 10022	$68	$13.2	$2.9	17	4	Seed, first, second, third or mezzanine
Leverage International Inc. C. Wasserman: (301) 230-0701	P.O. Box 2073, Potomac, Md. 20852	NA	NA	NA	NA	NA	NA
Mayfield Fund Norman Fogelsong: (415) 854-5560	2200 Sand Hill Road, Suite 200, Menlo Park, Calif. 94025	$350	$23.7	$14.3	28	16	No preference
Menlo Ventures DuBose Montgomery: (415) 854-8540	3000 Sand Hill Road, Building 4, Suite 100, Menlo Park, Calif. 94025	$150	$22	$18	20	18	Seed, first
Merrill Lynch Venture Capital Kelly Pan: (212) 980-0462	717 Fifth Avenue, 22nd floor, New York, N.Y. 10022	$120	$19.5	$16.5	13	11	Seed, first, second, third or mezzanine
Merrill, Pickard, Anderson & Eyre W.J. Pickard: (415) 856-8880	2 Palo Alto Square, Suite 425, Palo Alto, Calif. 94306	NA	NA	NA	NA	NA	NA
Mohr, Davidow Ventures Peter A. Roshko: (415) 854-7236	3000 Sand Hill Road, 1-240, Menlo Park, Calif. 94025	$80	$3.6	$1.9	8	5	Seed, first
Morgan Holland Ventures Corp. James F. Morgan: (617) 423-1765	One Liberty Square, Boston, Mass. 02109	$58.5	$5	$1	4	2	Seed, first
Morgenthaler Ventures T.A. Laufik: (216) 621-3070	700 National City Bank Building, Cleveland, Ohio 44114	More than $100	$10.7	$3.9	21	8	No preference
New Enterprise Associates Charles W. Newhall: (301) 244-0115	1119 St. Paul Street, Baltimore, Md. 21202	$386	$53	$28.4	78	48	Seed, first
Oak Investment Partners A. Merrill Ayers: (203) 226-8346	1 Gorham Island, Westport, Conn. 06880	$217	$31.2	$22.3	46	38	Seed, first
Pathfinder Venture Capital Funds A.J. Greenshields: (612) 835-1121	7300 Metro Boulevard, Suite 585, Minneapolis, Minn. 55435	$72.6	$8.3	$3.2	15	4	No preference
Raytheon Ventures D.S. Dwelley: (617) 860-2270	141 Spring Street, Lexington, Mass. 02173	NA	$25	$22	9	8	No preference
Robertson Colman Stephens Venture Fund Mari Coale: (415) 781-9700	One Embarcadero Center, Suite 3100, San Francisco, Calif. 94111	$150	$24	NA	24	7	No preference
SAS Associates T. Michael Christiansen: (213) 624-4232	515 South Figueroa Street, #600, Los Angeles, Calif. 90071-3396	NA	$4.5	NA	15	8	Second, third or mezzanine, follow-on
Scientific Advances Veronica Payer: (614) 294-5541	601 West Fifth Ave., Columbus, Ohio 43201	NA	NA	NA	NA	NA	NA
Sequoia Capital Don Valentine: (415) 854-3927	3000 Sand Hill Road, Building 4, Suite 280, Menlo Park, Calif. 94025	$300	$31	$21.4	37	22	No preference

(Continued)

1987 figures

Company Contact, telephone	Address	Total paid-in capital ($ millions)	Dollar investment ($ millions)		Number of companies invested in		Preferred stage of investment
			Total	Electronics	Total	Electronics	
Shaw Venture Partners Alan Dishlip: (503) 228-4884	851 S.W. Sixth Avenue, Suite 800, Portland, Ore. 97204	$50	$1.5	$1.4	7	6	Seed, first, second
Sigma Partners Cliff Haas: (408) 279-6300	2099 Gateway Place, Suite 310, San Jose, Calif. 95110	$33	$8	$7.3	12	11	Seed, first, second, follow-on
In Massachusetts: Gardner Hendrie: (617) 393-7396	342 Green Street, Northboro, Mass. 01532						
Southern California Ventures B. Allen Lay: (213) 216-0544	9920 Lacienega Boulevard, Suite 510, Inglewood, Calif. 90301	$12	$3.7	$1.7	8	4	Seed, first
Southwest Enterprise Associates, LP Leland Murphy: (214) 991-1620	5420 LBJ Freeway, 1266-2 Lincoln Centre/LB41, Dallas, Texas 75080	0	$2.6	$2.6	7	7	Seed, first, second
Summit Ventures Sarah Greene: (617) 742-5500	1 Boston Place, Boston, Mass. 02108	$119.7	$32	$19.2	22	11	First, second
Sutter Hill Ventures Tench Coxe: (415) 493-5600	2 Palo Alto Square, Site 700, Palo Alto, Calif. 94306	$110	$10	$4	8	4	Seed, first, second
TA Associates P. Andrews McLane: (617) 338-0800	45 Milk Street, Boston, Mass. 02109	$512	$52.6	$31.5	33	26	No preference
In New York: Jacqueline C. Morby: (212) 230-9870	147 East 48th Street, New York, N.Y. 10017						
In California: Jeffrey T. Chambers: (415) 328-1210	435 Tasso Street, Palo Alto, Calif. 94301						
3i Ventures Fred M. Haney: (714) 720-1421	450 Newport Center Drive, Newport Beach, Calif. 92660	NA	$13	$7	16	11	Seed, first, second, follow-on
Trinity Ventures Limited Noel Fenton: (408) 446-9690	20813 Stevens Creek Blvd., Suite 101, Cupertino, Calif. 95014	$10.1	$6.9	$3.3	11	8	No preference
TVM Techno Venture Management Peter A. Schober: (617) 574-8406	45 Milk Street, Boston, Mass. 02109	$100	$14.4	$12.1	13	10	First, second, third or mezzanine, follow-on
U.S. Venture Partners Steven M. Krausz: (415) 854-9080	2180 Sand Hill Road, Suite 300, Menlo Park, Calif. 94025	NA	NA	NA	NA	NA	NA
Vast Company Inc. Peter F. Lai: (704) 527-1537	500 Archdale Drive, Box 70, Charlotte, N.C. 28217	NA	NA	NA	NA	NA	NA
The Venture Capital Fund of New England Karen Reiche: (617) 439-4646	160 Federal Street, 23rd floor, Boston, Mass. 02110	[illegible]	$4.54	$1.5	13	3	First
Venture Funding Group Allan E. Skora: (212) 691-9895	49 West 12th Street, Executive Suite, New York, N.Y. 10011	NA	$9.4	$5.3	8	5	No preference
Wachtel & Company Inc. John D. Sanders: (202) 898-1144	1101 14th Street N.W., Washington, D.C. 20005	$5	$5	$4.8	5	3	Seed, first, second
Warburg Pincus Ventures Chris Browdy: (212) 878-0600	466 Lexington Avenue, New York, N.Y. 10017	$1,600	$375	$26	50	9	Seed, first
Woodside Fund Vincent M. Occhipinti: (415) 368-5545	850 Woodside Drive, Woodside, Calif. 94062	$30 (approx.)	NA	NA	NA	NA	Seed, first, second
Yamaichi Univen Company Ltd. Ms. Atsuko Fisher: (213) 626-1064	333 South Hope Street, Los Angeles, Calif. 90071	$1.6	$100	NA	NA	NA	No preference
Xerox Venture Capital L.J. Harris: (203) 968-3383	800 Long Ridge Road, Stamford, Conn. 06904	$55	$11.5	NA	18	NA	Seed, first

The PC market in Japan: Where's IBM?

In a crowded field of competitors, IBM has failed to wow the Japanese PC market. Will the PS/2 make a difference?

BY SHONEI KURITA

Japan has long been an ugly chink in IBM's armor. Big Blue, the world's largest computer company, does not have anywhere near the market dominance in Japan that it does in other countries, particularly in regard to personal computers.

According to a survey by the *Japan Economic Journal*, NEC Corp. ruled the Japanese personal computer market in 1986 by seizing a 51.3% share. At a distant second was Fujitsu Ltd., which controlled 15.2% of the market in terms of units produced. IBM Japan Ltd. came in third with a mere 7.0%, followed by Toshiba Corp. with 6.5% and Seiko Epson Corp. with 6.2%. Other companies accounted for the remaining 13.8%.

In terms of 16-bit machines, NEC's hegemony is even stronger. The Tokyo-based corporation owns roughly 90% of that market, according to various sources.

IBM Japan first started selling its 5500 Multistation PCs to the Japanese market five years ago. Last year, the company announced an upgraded series named Personal System/55. The announcement came just two months after Big Blue's U.S. introduction of PS/2 in April of 1987. The PS/55's top-end Model 70 similarly incorporates the Intel Corp. 80386 microprocessor, as does IBM's high-end PS/2 PC in the United States. And, not surprisingly, IBM's Japanese PCs also run on the same OS/2 software.

The new machines will help IBM better penetrate the PC market in Japan, asserts Kazufu Hotta, a director of workstation marketing. "As ICs have been regarded as the rice or oil of industry in the 1970s and 1980s," he says, "I think the Personal System will be integrated into every industry as a box with an operating system in the 1990s. There is one user, for example, who wants to integrate our PS/2 with OS/2 into their electronic microscope products."

By using Systems Application Architecture, Hotta asserts that IBM will standardize the user interface among all Big Blue computers, from large mainframes to personal computers. This, contends Hotta, will insure the compatibility of applications software on a worldwide basis. And because PS provides a unified interface for end users, IBM Japan's new PCs have gained quick acceptance in the marketplace, according to Hotta. "Nihon Insurance, for example, decided to install 5,500 PS/55s, in addition to 1,700 system 36s, in the coming year," he says. "And our installations will expand."

IBM Japan's PCs are not mere imports from the United States, but rather, "Japanized" versions of them.

Norio Hasewaga

IBM Japan's Hotta: "I think the Personal System will be integrated into every industry . . . in the 1990s"

"Five years ago," says Hotta, "we answered the advanced requirements of Japanese users who demanded high resolution graphics of 24 by 24 dots as well as Kanji [Chinese ideogram] processing . . . with the capabilities of computation, word processing and communication."

This technology, which was developed for the Japanese market, has been extremely useful elsewhere, according to Hotta. "Recently in the U.S.," he says, "users' requirements have been shifting to the same level of high-resolution image or graphic processing. So we globally named our new products as Personal System by using the same parts."

Furthermore, Big Blue recently announced a powerful laptop computer which was developed in Japan. "Our Yamato Laboratory will play an important role in IBM's worldwide laptop products," boasts Hotta.

In addition to the Japanized PS/55 series, Big Blue sells imported PS/2s in Japan, mainly to the subsidiaries or branches of foreign multinational companies. At the same time, IBM Japan exports its PS/55s to the foreign subsidiaries of Japanese multinational corporations.

Indeed, Big Blue has done well in the business environment. When limiting the 16-bit PC market to the corporate end-user, another *Japan Economic Journal* survey of 711 companies showed that the highest market share belonged to IBM. Big Blue's 26.6% share was followed by Fujitsu's 24.8%; Hitachi Ltd.'s 21.3%; NEC's 11.5%; Nippon Univac Kaisha Ltd.'s 6.4%; Burrough Company Ltd.'s 3.4%; and NCR Japan Ltd.'s 3.1%. Other various companies made up the remaining 2.9%. The total units shipped to this market segment in Japan was about 2 million in 1986. In addition to a salesforce of 3,000 employees, IBM Japan now

Norio Hasewaga

NEC's Watanabe: "We use the Intel microprocessors in order to realize more performance"

has 130 marketing agents and VARs to sell its personal computers and System 36 products.

NEC's 90% share

IBM will need the additional marketing muscle to challenge NEC, a company widely acclaimed to own 90% of the 16-bit Japanese PC market. NEC executives, however, downplay their near monopoly. "We actually do not own such a large share," insists Kazuya Watanabe, an NEC vice president. "If you look at the marketplace only on the basis of the major dealers' shops, we have 90% in terms of units sold. However, NEC's share in the entire 16-bit market is between 65% and 70%. And if you look at the total PC market, including 8-, 16- and 32-bit machines, our share seems to be between 50% and 55% in terms of revenue."

Watanabe predicts that the mainstream of the market will continue to be 16-bit machines for the time being, even if the demand for 32-bit machines surges. "A survey by the Japan Electronic Industry Development Association shows that the annual shipment of 16-bit machines finally surpassed that of 8-bit ones just in 1987," notes Watanabe.

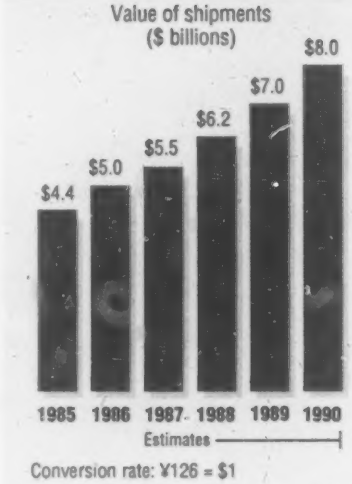
The association's survey also reveals that 40.5% of the machines shipped were used for business purposes, 13% for scientific computation or measuring and control applications, and 46.5% for education, hobby and home usage. NEC's PC9800 and 8800 Series are widely used in all of the end-user market segments, both as standalone machines and as computers in a network. NEC's 5200 Series is challenged by IBM and Fujitsu PCs in the microcomputer to mainframe link (MML) marketplace.

Some of NEC's PCs incorporate *both* the company's own V-series microprocessors and Intel's. Watanabe explains why: "We use our own V-series microprocessors in order to secure the complete compatibility of our software to our previous machines. We use the Intel microprocessors in order to realize more performance." Interestingly enough, Watanabe adds that some of NEC's 32-bit PCs and laptop computers that are manufactured in Boston and Atlanta have been selling well in Japan.

NEC's success in the Japanese PC market has attracted clone makers, much as IBM's success in the United States has attracted the likes of companies like Compaq Computer Corp. of Houston. In fact, three dominant PC groups have arisen in Japan:

- NEC and its clone maker Epson;
- the AX project group which aims at providing a unified Japanized version of the IBM PC/AT. The group is jointly promoted by ASCII, Japan Softbank and Microsoft K.K. Several IBM PC clone makers — including Alps Electric Company Ltd., Kyocera Corp., Mitsubishi Electric Corp. and Sanyo Electric Company Ltd. — are basically exporters and are not a major force in Japan;
- the alliance between Fujitsu and Matsushita Electric Industrial Company Ltd.

Japanese PC market



Conversion rate: ¥126 = $1

Source: Japan Electronics Industry Development Assoc.

Fujitsu's Kuwahara: Sales of our 80386-based PCs have been three times higher than what we expected

Executives at Fujitsu, Japan's No. 1 mainframe vendor, clearly see the PC as an integral part of their overall business. "Low-level machines including personal computers and workstations have very quickly become strong recently, and the future of mainframe computers depends on this trend," asserts Akira Kuwahara, general manager of the marketing promotion division. "The importance of software with open architecture for low-end machines will increase more and more in an MML environment."

Fujitsu is targeting four market segments — big business, education, VARs that are medium-sized software houses, and dealer shops. "In the big business segment, we are going to rapidly supply users with the strong power of our 32-bit 80386 FMR-70 PC which uses OS/2," says Kuwahara. "Our recent sales performance in this segment has been three times higher than our expectation. The growth rate of the entire FMR series last year was 200%." The average growth rate of Fujitsu's FM series, which uses Intel's 80286 and 80186 microprocessors, and Fujitsu's G series, which uses Motorola Inc.'s 68010 and 68020 microprocessors, should be around 35% this year, according to Kuwahara. □

Norio Hasegawa

Motorola stalks the Hong Kong ASIC market

Amid widespread skepticism, Motorola is investing more than $200 million in Hong Kong's ASIC market. Will the gamble pay off?

BY EUAN BARTY

Motorola has the Hong Kong electronics industry abuzz. In a bold move, the company recently announced that it would invest more than $200 million to build a state-of-the-art ASIC manufacturing plant in Hong Kong. The seafront project, christened "Silicon Harbor," will utilize technology one generation ahead of similar facilities now in the United States and Europe, according to C.D. Tam, head of Motorola Semiconductors Asia-Pacific Ltd., a subsidiary of Motorola Inc., headquartered in Schaumburg, Ill.

Tam asserts that Silicon Harbor, conspicuously named after California's Silicon Valley, will act as a catalyst. "Many years ago when the electronics industry was born," he says, "a lot of the pioneering was done in California. . . . By building an advanced semiconductor plant in Hong Kong, we believe that we can generate a similar capability here."

Amid such visionary talk, critics wonder whether Motorola is investing wisely. Somewhat suspect is the company's strategy of using Silicon Harbor primarily to support the local ASIC market which, by most estimates, is tiny. Also questionable is Tam's lofty goal of duplicating Silicon Valley in Hong Kong, a country which will revert to Chinese sovereignty in 1997.

Nonetheless, Motorola remains undaunted. Although the company will not divulge specifics, Tam confides that Silicon Harbor's cost will top $200 million, more than the cumulative amount of money that the company has invested in Hong Kong over the past 20 years. Unofficial estimates within the local industry put the figure higher, at around $300 million. If those estimates are accurate, Motorola will be spending an amount equivalent to 43% of the *total* U.S. investment in Hong Kong's electronics industry for 1986.

C.D. Tam, head of Motorola Semiconductors Asia-Pacific Ltd., is hoping that his company's more than $200 million investment in Silicon Harbor will pay off

Due for completion in two years, Silicon Harbor will be a 300,000 sqare foot plant dedicated to the fully automated production of ASICs, application-specific integrated circuits such as standard cells and gate arrays. The facility will employ 800 people, two-thirds of whom will be professionals or engineers.

How busy the new plant will be is uncertain. Bulent Celebi, product marketing director at National Semiconductor Asia-Pacific Marketing Ltd., estimates that the total ASIC market in Asia, excluding Japan, was worth only $50 million in 1987. According to Celebi, Taiwan accounted for 35%, Korea and Australia 25% each, and other countries — including Hong Kong — shared the remaining 15%.

Such disappointing figures do not faze Tam, who is expecting explosive growth in the marketplace. "The whole world is shifting toward application-specific products. There will be a growing need in the 1990s to provide this technology in Asia," he asserts.

A peanut market

Big deal, says Goh Geok Ling, vice president of Texas Instruments Inc.'s Asia-Pacific division. "The growth rate itself is insignificant because the base is so small. If you have one peanut and then you have two, you've got a 100% growth rate, but it doesn't tell you much about the peanut business."

Still, Tam insists that a huge Asian ASIC market will indeed develop. In particular, he is counting on Hong Kong electronics companies doing

Copies of articles from this publication are now available from the UMI Article Clearinghouse.

For more information about the Clearinghouse, please fill out and mail back the coupon below.

UMI Article Clearinghouse

Yes! I would like to know more about UMI Article Clearinghouse. I am interested in electronic ordering through the following system(s):

☐ DIALOG/Dialorder ☐ ITT Dialcom
☐ OnTyme ☐ OCLC ILL Subsystem

☐ Other (please specify)_____
☐ I am interested in sending my order by mail.
☐ Please send me your current catalog and user instructions for the system(s) I checked above.

Name_____
Title_____
Institution/Company_____
_____
Department_____
Address_____
City_____ State_____ Zip_____
Phone (_____)_____

EB5-15

Mail to: University Microfilms International
300 North Zeeb Road, Box 91 Ann Arbor, MI 48106

more systems manufacturing which will require a larger supply of local ASICs. And where will these products be headed? China, says Tam. He points out that with the Hong Kong dollar pegged to the U.S. dollar — making the currencies effectively indistinguishable — it is much cheaper for China to buy products from Hong Kong than from Japan. "Just think how many color televisions will be sold there in the future," he remarks.

The Hong Kong-China link will become increasingly important, especially as 1997 nears. This could explain Motorola's choice of Silicon Harbor's locale. "To Hong Kong manufacturers, it really doesn't matter whether you put it here or elsewhere," says National Semiconductor's Celebi. "But in terms of China support, it's a good idea."

Apparently Motorola has other good ideas as well. Unusual for a Hong Kong manufacturer, the company puts much emphasis on staff relations. It trains new employees straight from school, has a planned job rotation program to relieve tedium and ensure continuity of skills, bases promotions and bonuses on performance, and operates a profit-sharing scheme.

It seems to work. Motorola has a low labor turnover rate which is the envy of other electronics manufacturers in Hong Kong. Tam asserts that employee turnover is only running at around 0.5% each year, even without adjusting for emigration. "Our stability is due to our policy rather than anything else," says Tam.

Nonetheless, Motorola's choice of Hong Kong as the site for a major investment in ASICs may not be prudent. "The primary area of ASIC utilization is logic replacement and there's not a lot of logic to be replaced in Asian applications," asserts National Semiconductor's Celebi.

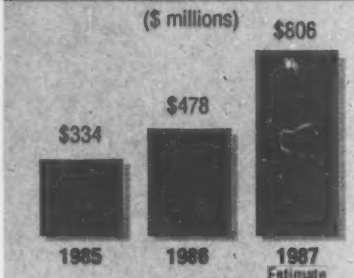
Furthermore, Celebi believes that the structure of Hong Kong businesses will work against the sort of transformation that Motorola's Tam envisages. "To do anything significantly high tech, you're talking large resources and large companies. You can't do it with a 15-man company," says Celebi, referring to the fact that Hong Kong's electronics industry consists primarily of smaller companies.

Celebi is not the only one with doubts. "In Hong Kong, it's very difficult to get highly skilled labor for all levels of fabrication. Also, there is a limited local market, unlike Japan, Korea or Taiwan," argues James N. Chapman, a regional marketing manager for Intel Corp., headquartered in Santa Clara, Calif.

Consequently, Intel will concentrate its efforts elsewhere. "There are opportunities coming up in Taiwan and we believe the market will warrant investment within the next five years," says Chapman.

Still, National Semiconductor's Celebi has not ruled out the possibility of his company expanding in Hong Kong. "Some ideas have been kicked around," he says. "Management has certainly taken note of what Motorola's doing." ☐

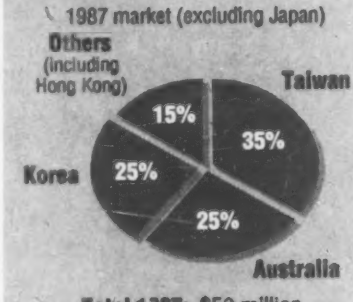
Hong Kong's semiconductor consumption



Source: Dataquest Inc.

Motorola's bet is that Hong Kong's chip use is rising fast — and its use of ASICs is rising even faster . . .

Pacific Rim ASIC market



Source: National Semiconductor Corp.

. . . but it's a huge bet. So far, Asia's ASIC market is tiny

PC fax: The phone is ringing but will anyone answer the call?

Egged on by sales of fax machines, sales of PC fax boards are expected to skyrocket. Suppliers, though, are skeptical

BY LAMONT WOOD

It's a market that has grown from two competitors in 1986 to more than 20 in early 1988, and one in which unit sales are expected to skyrocket by a factor of 10 by 1991.

It's also a market where the participants keep looking over their shoulders as they try to plumb its potential, wondering if they can really bring together two approaches to office automation as far apart as East and West — "fax" machines, and microcomputers.

"Our biggest challenge is to get our dealer base educated. Most computer dealers don't carry fax machines. And there's a tremendous lack of end-user awareness," asserts Joel Port, computer products manager for Panasonic Industrial Co. in Secaucus, N.J. He notes that in one poll, half of the executives questioned thought a fax machine was "some kind of copier."

A fax machine is indeed a sort of long-distance copier. You dial the phone number of the fax machine you want to send to, feed in a document, and the page is scanned and transmitted — in about 25 seconds — to the distant machine, where a facsimile is printed out.

Today's standard fax machines use the Consultative Committee on International Telegraphy and Telephony's (CCITT) Group 3 protocol — digital transmission at 9,600 baud. Since they are all based on the same CCITT protocol, any Group 3 fax machine can send to any other Group 3 machine (and most can send to Group 2 machines as well) anywhere in the world. And since anything on the page — text, graphs, doodles — will be transmitted, in seconds, fax is fast replacing the telex network, with its slow speed and limitation to uppercase letters.

An add-in fax board, which contains a fax modem and the software necessary to control it, enables a personal computer to become its own fax machine. Depending on the software, documents generated on the PC can be sent directly to a fax machine, without the intermediate step of being printed on paper. Using a variant of optical character recognition software, fax images received by the PC can be turned into text files.

There is black magic in combining digital and analog on a PC fax board

The advantages? Price is no longer one of them. PC fax boards average about $1,000, but "street prices" for entry-level standalone fax machines have fallen to that level and even lower. Some PC fax boards cost less than $500, but they are using 4,800 baud or even 2,400 baud modems. They operate normally, since these are speeds that fax machines would "step down" to under bad line conditions, but transmission times — and phone bills — are proportionally higher.

"Broadcasting" — sending to multiple recipients — is usually cited as the major advantage of these PC fax boards. This capability is otherwise only available on the higher end fax machine costing $2,500 and up.

"An example would be a sales manager who has a bulletin he wants to get out to the salesforce," says Jim McNaul, vice president of strategic planning at Datacopy Corp. of Mountain View, Calif. "He can compose the document on the PC, reference it to a standard list of sales offices, and schedule transmission for that night when rates are lower. The next morning it will be at each office."

But the boards' disadvantages may overshadow their appeal. "The only folks we recommend purchasing these boards are "information brokers" — those [who are] dependent on large amounts of information, use a PC and don't want to leave their desks," says Shelly Bakst, senior analyst at International

© Elsevier

Data Corp., a market research firm in Framingham, Mass.

"There are too many frustrations for those who don't depend on PC-based systems. You have to install the board. Most people only have half-page displays. It can take 10 minutes to print out the image that it took only 25 seconds to receive. You need a dedicated phone line and you need to leave your PC on to receive incoming faxes. And to make good use of the board, you need a document scanner, and those cost $2,000 to $3,000," notes IDC's Bakst. "And standalone fax is very simple to use."

Nevertheless, fax boards are finding a following. Sales have grown from raw beginnings in late 1985 to 16,555 units, worth $19 million, in 1987, and are expected to reach 188,000 units, worth $75 million, in 1991, says Bakst. Donald Ryan at the research and consulting firm of CAP International in Marshfield, Mass., expects sales of 225,000 units in 1991.

"There's still a lot of room left in the market because it's still application-driven. If someone needs a PC fax board to do something, then price is not their main criteria," says Port at Panasonic. "It will be another year before all the people who need them have them."

Thereafter, three forces are expected to continue driving demand: cheaper prices, more applications and the growth of the regular fax market.

Prices today remain about where they were when the market was born, but George Mount, product manager for PC fax boards at GammaLink Inc. in Palo Alto, Calif., expects prices to drop 25% to 30% over the next year, as a result of expected price reductions in fax modems from Rockwell International Corp., which practically has a monopoly on that market. The modem, adds Mount, is 80% of the manufacturer's hardware cost.

That was a surprise to Dori Braun, fax modem product manager at Rockwell in Newport Beach, Calif. He says that Rockwell's modem sells at a 1,000-unit price of $90 for the 3-chip R96F and $100 for the 2-chip R96MD. No future price reductions have been announced, although Braun adds that prices have fallen by a factor of four or five since the R96F

came out in 1985 (replacing a 3-board modem). He also adds that Rockwell is working on a single-chip fax modem. Growth of the market may also allow PC fax board makers to enjoy larger quantity discounts, he says.

Rockwell also does not expect to see significant competition soon, Braun says. "This is not a simple technology — there is black magic in combining digital and analog."

As for applications, "In the next year we expect it to become a more feature-intensive market," says Port at Panasonic. "People will be adding Hayes modems, scanner interfaces, and encryption circuits to the fax board. The additional features will keep the price at the original level, while prices for the first generation of boards will drop a couple of hundred dollars." He expects the market to double every year for the next three years.

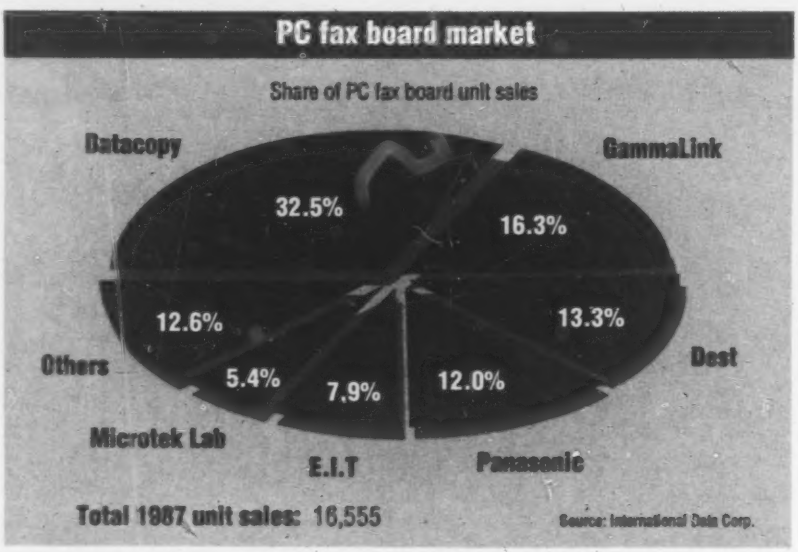
Ken Camarro, president of Camarro Research in Fairfield, Conn., estimates that 187,000 fax machines were sold in 1986, 450,000 in 1987, and that up to 800,000 will be sold this year. About 75% of the 1988 sales will be in the under-$2,000 range, predicts Camarro.

But anybody interested in the PC fax board market might want to heed the words of GammaLink's Mount.

"It took me a year to figure out that these were not replacements for fax machines," he says. "The user has to be PC-literate, and you need a fast laser printer, a fast scanner and a fast CPU before you have the equivalent of a fax machine," Mount adds.

"If you have time sensitive documents being produced on a PC and sent to a fax machine, then you have a potential use for these boards. Otherwise, buy a fax machine. These boards are probably doing more to sell fax machines than anything else that's come along," Mount says.

Lamont Wood is a Texas-based business writer



Six players divvy up the lion's share of the PC fax board market

Rigid-drive media makers spur production spending

Makers of thin-film disks are spending big to keep up with disk-drive firms' demands. The trick is in how big to spend, which calls for smart forecasting

BY ANDREA COHEN

For years, disk drive makers got by with disks coated with a magnetic oxide layer. But the emergence of thin-film technology, whereby disks have coatings of a much higher magnetic density sputtered or plated on, has the drive makers crying out for thin-film disks. As a result, the manufacturers of thin-film media are finding that the main question regarding production is not necessarily how much, but rather, how fast?

Currently, many manufacturers, such as Komag Inc., based in Milpitas, Calif., are running production lines 24 hours a day, seven days a week. Komag now has four sputtering lines in operation and, according to Hunt Payne, vice president for marketing, the company expects to have three more lines installed and operational later this year. Lin Data Corp., in Santa Clara, Calif., another manufacturer of sputtered media, has four lines that together make 200,000 disks monthly, with an additional one coming on line this month.

The media makers' capital investment surge does not come cheap. A fully equipped sputtering machine runs about $3 million and the price tag for a full production line hovers around $8.5 million. "We're absorbing capital investments at a pretty high rate — something around $3 million to $4 million a quarter," claims Terry Wood, sales and marketing vice president of Milpitas, California-based Domain Technology Inc., which is producing about 85,000 disks per week.

Komag's Payne adds that whereas a few years back most people thought that an investment of two to three years and $10 million to $12 million was sufficient to start a thin-film media company, in reality, the figures turned out to be more like $20 million to $25 million and four to five years. Komag will spend better than $25 million on capital investment in 1988 alone.

Peter Gove, general manager for marketing at Peripheral Components International (PCI), the recording head and disk vendor for, and subsidiary of, Control Data Corp., allows that PCI has already invested $10 million in its thin-film projects. He adds that providing heads or disks for leading-edge drive programs entails yearly expenditures of "several million dollars, just to stay current."

In such a capital-intensive market — and when the disk drive industry is almost as capricious as the semiconductor business — it's crucial for these media manufacturers to have accurate forecasts of market demand. If a thin-film maker forecasts accurately, it uses its money well. If a manufacturer puts in more capacity than is needed, it is risking a big overhang of investment which won't pay off for a long time.

Ouji-board forecasts

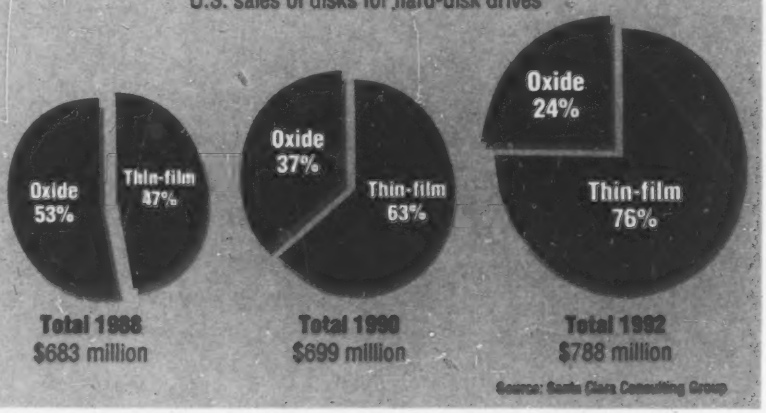
James Porter, president of Los Altos, Calif., market research firm Disk/Trend Inc., jokes that these companies anticipate demand "with a Ouji board." He explains that the makers of thin-film media are getting very large estimates from the drive manufacturers, who are still canvassing their own customers. "So [the disk makers] don't dare make the quantities suggested to them in total by the drive manufacturers. So they have to [trim back] a bit in their own judgement call — as to how much of those requirements they're being told about are real."

In line with that, Domain's Wood explains that his company figures market demand by exploring at least two levels of production, looking both at projections from customers and from customers' customers. Right now, however, Wood says that high demand means that Domain can pretty much "pick and choose targets."

According to Tazz Pettebone, senior vice president of Akashic Memo-

Thin-film vs. oxide hard-disk drive media

U.S. sales of disks for hard-disk drives



Source: Santa Clara Consulting Group

ries Corp. of Santa Clara, sales-growth projection has been easy: "For the past two years, there's been a higher demand for our product than we've been able to keep up with, even though we've continued to grow." However, Akashic has surveyed its customers to chart their needs through 1989. The company currently runs three sputtering lines, with two more on order for later this year.

Risky business

The industry "has swung more rapidly toward thin film than anybody thought," says Porter. Yet, although demand is unquestionable, the analyst points out that producing thin-film disks is still a risky business. "At one point," Porter says, "there were probably 40 or 50 thin-film media companies planning production or actually in production." Now the market has shrunk back to a small number of companies producing 2 million to 4 million disks a year, and a few other companies still "far back in the pack," producing 100,000 to 200,000 disks a year. Porter questions whether the latter will be able to get enough market share to produce enough disks and bring costs down enough to stay afloat.

Gary Davis, sales manager for Eikon Inc., in Simi Valley, Calif., the only privately owned volume player, agrees. This manufacturer of plated disks is currently running at near-capacity, producing 50,000 disks a month. "It's a major, major roll of the dice to be in this business because on the one hand you're dealing with a product that's extremely difficult to build from a technical standpoint, and has to be built in Class 100 clean rooms. . . . On the other hand, it's a product which, for marketing reasons, must behave like a commodity. Therefore, yields and volume must follow technology."

Davis anticipates the thin-film market to grow at an average compound annual rate of 68% through 1990. A February 1988 report from the Santa Clara Consulting Group (SCCG), a market research firm based in Santa Clara, predicts the U.S. thin-film market will grow from 13.5 million units in 1987 to 21 million units in 1988, with 1992 figures reaching around 48 million units. In revenue, that means a jump from roughly $240 million in 1987 to $320 million in 1988, and all the way up to $540 million by 1992.

Thin-film media makers, such as Komag, must plan on spending around $8.5 million for a full production line

But where, exactly, are all these disks going? According to Disk/Trend's Porter, high demand is the result of two factors. First, thin-film disks are replacing oxide disks. Secondly, thin-film media are being used on newer drives that are being pulled through by rapid growth in the personal computer market and in technical workstations.

High-end, high-performance 5.25-inch drives are heavily used in the 380MB class of products and in replacing older drives in minicomputers. And 3.5-inch drives "are growing like topsy," says Porter, "because the PC industry is now going to 3.5-inch drives — Apple, all the Japanese companies, Hewlett-Packard, and finally in this last year, IBM." Practically every 3.5-inch drive, except IBM's 20MB drives built in Fujisawa, uses thin-film disks. Porter believes that when IBM introduces its higher capacity 3.5-inch disk drive later this year, it will incorporate sputtered thin-film media.

The Japanese have invested substantially in thin-film media

Demand for the mini-drives will see media maker Akashic, whose production for the past year and a half has been dedicated to 5.25-inch disks, entering the 3.5-inch market by midyear. However, some participants believe that demand for 5.25-inch thin-film disks will remain strong, accounting for two-thirds of demand through the end of 1988.

Shortages or no?

There's some question over whether the demand rush will mean shortages of thin-film product. San Jose-based Maxtor, which uses thin-film disks in all its high-capacity, high-performance 5.25-inch drives, is getting all the disks it needs, according to vice president for operations, Steven Kitrosser.

However, Akashic's Pettebone warns that with the rapid conversion of newer products to thin-film media, "it would appear as if there would be a total shortage of supply" later this year or in the early part of next year. "The migration from oxide to thin film is just horrendous," he exclaims.

Shortages ought to mean higher prices. Yet Mark Geenen, associate director with SCCG, foresees strong price erosion. Currently, some thin-film manufacturers are selling lower end disks in the $10 to $12 range. Three and one-half inch disks in the 150MB to 170MB arena go from around $17 apiece up to $23. Higher end disks are currently priced at around $30 and should see a significant price decline this year.

Not to be overlooked are the Japanese, who have put hundreds of millions of dollars into thin-film media and whose installed capacity, according to Geenen, is "very large." He says that although the Japanese had grandiose plans about shipping a lot of media into the United States, they became very uncompetitive from a price standpoint when the dollar nose dived.

However, several Japanese companies, such as Fuji Electric, Mitsubishi Electric Corp. and Seiko Epson Corp. are now opening U.S. sales offices. Although U.S. firms currently have a lock on the thin-film business, Geenen foresees a limited number of contracts signed this year between Japanese media suppliers and U.S. drive manufacturers. □

Compatible makers push 3480 tape drives downward

Compatible tape drive makers are giving IBM competition in the high end. Now they may migrate 3480s to the midrange

BY BRIAN DEAGON

One of the great computer mysteries of the past decade has been IBM's direction in the high-end tape storage market.

As the harbinger of most computer standards, IBM launched the tape storage industry in new directions in 1971 with the introduction of the Model 3420 family of reel-to-reel tape drives, but then left manufacturers in a lurch for 12 years.

Not until IBM resurfaced in 1984 with the Model 3480 Magnetic Tape Subsystem has high-end tape drive technology evolved significantly. Several other nonstandard alternatives have been laid on the vendor's table but few have come to feast on the offerings.

Once introduced, the 3480 became an overnight standard. Computer industry vendors and integrators have embraced the 3480 technology and plan to make it their standard platform for offloading and storing large volumes of data from mainframes and networked minicomputers, industry watchers agree.

"Our customers like the 3480 solution," says Fred Hanhauser, Unisys Corp. program manager for tape and optical devices. Unisys has been shipping 3480-compatible systems since December. "The device has been stable and performed well in labs," he says.

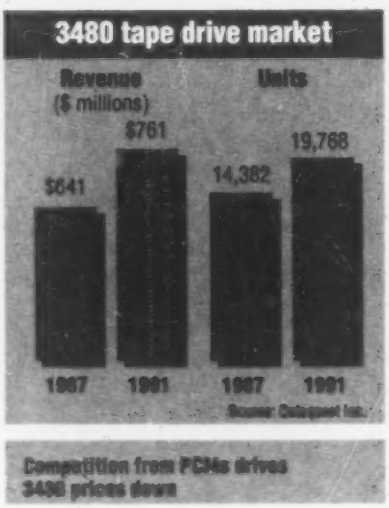
Digital Equipment Corp. is also evaluating 3480 technology and will likely adopt it this year, several analysts report. Other candidates studying the technology include Data General Corp., Hewlett-Packard Co. and Wang Laboratories Inc., observers say.

A 3480-compatible version will also be remarketed by European mainframe vendor International Computers Ltd. and by Comparex, a European joint venture between BASF AG and Siemens AG. The technology is also in use in Japan by Fujitsu Ltd. and Hitachi Ltd., which make their own 3480 versions.

"We'll see all the top 1,000 data centers convert to the 3480 technology by the end of 1989," predicts Joe Phillips, 3M Co.'s business development manager for computer tape products. 3M annually polls about 400 data centers nationally, Phillips says.

EMC Corp., Hopkinton, Mass., a systems integrator, will also sell 3480 or compatible versions into the DEC, Hewlett-Packard, Prime Computer Inc. and Wang marketplace. "We see the whole high-end minicomputer market going for the 3480," says Michael Egan, EMC's vice president of new product development.

The market for 3480 tape drives grew an estimated 20% to $641 million in 1987, from $535 million in 1986. By 1991, the market for IBM and compatible 3480 tape drives will grow to $761 million, a compound annual growth rate of 7.3% over six years, projects Dataquest Inc., a San Jose-based market research firm. The 3480 will displace about 70% of the high-end reel-to-reel tape drives in use today by 1991, industry watchers speculate.



"The mainframe computer vendors are definitely going for the 3480 and compatible format," says Louise Biggs, Dataquest senior industry analyst. "We believe the technology will also come down into the high end of the minicomputer market as well."

Total shipments of 3480 and compatible tape drives will grow to about 19,768 in 1991, up from 14,382 in 1987, says Biggs. A typical 3480, consisting of one 3480 tape controller and a tape unit which supports two tape drives, costs about $100,000.

The dinosaur and buggy whip

The 3480 introduction came none too soon for IBM. While IBM rested on its laurels with the 3420, several companies took significant market share away from IBM by improving on the basic reel-to-reel technology. One benefactor was Storage Technology Corp., which captured more than half of the high-end tape storage business from IBM during the interim.

IBM's foot dragging in tape storage technology was due to its penchant for hard disk storage technology, principally the Model 3380. IBM reasoned that users would prefer the benefits of on-line information stored on fast hard disk drives, compared with slower and more cumbersome tape storage devices. That fueled predictions that 0.5-inch reel tape drives would go the way of the dinosaur and buggy whip. In the meantime, tape processing flourished and worked its way down to the microcomputer.

Although shipments of high-end reel-to-reel drives are on the decline,

the concept of storing data on tape is firmly entrenched among major data-processing centers worldwide. With the growing acceptance of the 3480, 0.5-inch tape as a storage medium will remain an industry standard into the year 2000, notes Raymond Freeman Jr., president, Freeman Associates Inc., a Santa Barbara, California-based market research organization.

The 3480, when compared with the 3420, was evolutionary for several reasons. It reduced floor space and power needs by about 60% and cut by more than half the amount of time it took to transfer data on and off a system. The 3480 is also revolutionary, in that IBM tossed out the notion of using cumbersome 10.5-inch tape reels and instead christened the 3480 tape cartridge. The cartridge encloses the 0.5-inch media in a hard plastic shell that easily fits in the palm of a hand. One IBM cartridge can hold 200 megabytes of data, compared to 165MB on reel tape, which contains an extra 1,800 feet of tape.

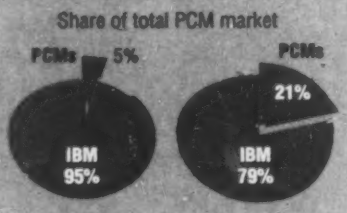
The IBM 3480 will recapture much of the market share IBM lost to competition in the high-end tape storage business. For one, the technology has been so difficult to duplicate that manufacturers intent on building plug-compatible 3480 tape systems have taken three years and spent upward of $25 million each getting their products to market. During that three-year window of opportunity, IBM has shipped more than $1.5 billion worth of 3480 products since 1984, according to market estimates.

3480 compatible makers

Four companies began shipping plug-compatible 3480 systems in volume this year and hope to give IBM a run for its money. These vendors expect to see good growth in 1988, as more and more data-processing centers begin to replace an aging fleet of 3420 and compatible drives. They are: Aspen Peripherals Corp., Longmont, Colo.; Fujitsu America Ltd., San Jose, Calif.; Hitachi America Ltd., San Bruno, Calif.; and Storage Technology Corp., Louisville, Ky. All four make OEM versions of the drive and all but Aspen also market the systems to end users.

Fujitsu and Hitachi market their drives through Memorex Telex and National Advanced Systems Group, respectively. Also, StorageTek has launched its end-user version, called the 4980, and recently clinched an OEM deal to supply International Computers, based in Britain.

IBM vs. PCMs in 3480 market



PCMs will capture 21% of the 3480 tape drive market by 1991

The 3480 plug-compatible manufacturers intend to compete against IBM in several ways. They hope to offer drives about 5% to 15% below the price of an IBM system, higher reliability, better service contracts and trade-in terms, and a better performing product. For example, Hitachi sells a version with a unique data compression device that can store upward of 500MB on a single cartridge, compared to IBM's 200MB cartridge.

Dataquest projects that these plug-compatible manufacturers will capture 11% of the 3480 market this year and 22% by 1991. Those projections could be altered once IBM introduces an improved version of the 3480 at some future point, acknowledges William Reedy, IBM manager for storage support marketing.

"The success of other vendors will bring more attention to the market"
William Reedy, IBM

"The competition is a mixed blessing," says Reedy. Although the competition presents a tough challenge to IBM, it nonetheless knights the technology as a de facto industry standard. "Our biggest problem was developing inertia. The success of other vendors will bring more attention to the market," Reedy says.

A market shakeout of sorts could occur in the future, however. Analysts caution that there is little room left for another major player at this time. In addition, there is a critical oversupply of 3480 cartridges, which indicates that vendors are currently satiated, notes Freeman of Freeman Associates.

Midrange fueling demand

Several factors are projected to fuel future demand of 3480 systems. One is the establishment of an industry standard interface beyond the IBM standard, such as SCSI or IPI III, which would speed up integration, observers say. Another development to watch is the anticipated introduction of a midrange tape storage solution that would also use the 3480 cartridge.

The 3480 design is so sophisticated that building a midrange system that would be able to exchange data with the high-end 3480 is an extremely difficult task. Cipher Data Products Inc. of San Diego has been developing such a product for IBM for more than 44 months. The delayed introduction of the IBM/Cipher product family has emerged as the new mystery in tape technology.

However, IBM recently gave Cipher the go-ahead to introduce its version of the products, with no indication whatsoever if Cipher's product will emerge as an acceptable midrange solution, or be compatible with anything IBM might later introduce.

"It's becoming more and more important to be able to transfer data from the low end to the high end," notes Dennis Alessio, eastern regional sales manager for Hitachi America.

"The lack of a midrange solution could be a serious problem," acknowledges Jay Bretzman, an industry analyst for International Data Corp., a market research firm.

This lack of a midrange 3480 solution is a key reason why leading suppliers of 0.5-inch reel-to-reel tape drives say business is good. But despite what IBM might do in the mid- and low-end tape storage arena, it has a sure winner with the 3480 at the high end, industry watchers acknowledge, and the compatible hyenas are sitting at the table to feast. □

High-speed modem madness: In search of standards

Data compression, a technique which can double or triple a modem's speed, is changing the face of the 9,600 bps segment

BY GEOFFREY L. SMITH

Personal computer companies have spent millions in research dollars meeting the challenge of higher speeds at cheaper prices. But for modem manufacturers that provide the links among PCs over public phone lines, the real challenge involves standardization.

Currently, the modem market is plagued with a lack of standards, especially in the fledgling market for high-speed dial-up modems — those that transmit at 9,600 bits per second (bps) and faster — resulting in confusion for customers, and a slow start for a promising market.

And recently, a technology has emerged that may make things even worse. Data compression, which can double or triple a modem's speed when used to transmit certain kinds of data, is now appearing on slower, less expensive modems, making them competitive with the 9,600 bps modems. The technique involves identifying repetitive patterns — such as zeros in a spreadsheet — so they can be encoded into a smaller number of characters. Some companies incorporate data compression into the chips in their modems while others sell add-on units.

Talk to me

James Jordan, president of Telebit Corp. in Cupertino, Calif., one of dozens of companies in the 3-year-old, 9,600 bps dial-up market, calls the market "a mess" because of the huge disparity in technology used to make 9,600 bps modems. "From a user's standpoint, it's very confused," he says. "None of the manufacturers make modems that talk to one another. There are no standards. It's an area where standards are needed very badly."

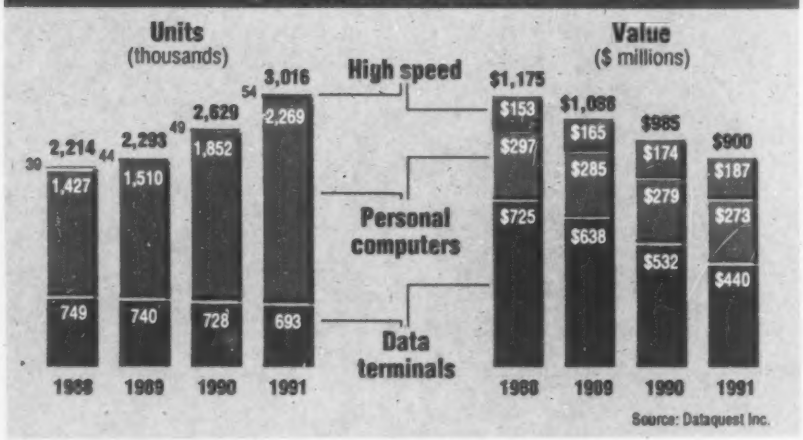
When the 9,600 bps dial-up market got started in 1986, two companies dominated the market. Telebit Corp. and MicroCom Inc. were pulling in most of the market's $20 million in sales, according to Dataquest analyst Larry Cynar. But even after about a dozen others entered the field last year, the market only grew to about $30 million, Cynar says. Below the 9,600 level, a low-end 1,200 bps segment is firmly in place. In that segment, Hayes Microcomputer Products Inc. in Atlanta has created a de facto standard. But to date, says Cynar, no market leader has emerged to drive the high end.

Hayes makes a $1,200, 9,600 bps modem as part of its V series, but it uses proprietary technology that prevents it from communicating with modems from other manufacturers. Meanwhile, other manufacturers offer the V.32 standard, recommended by the Consultative Committee for International Telegraphy and Telephony (CCITT), for transmitting data at high speeds over public telephone lines. However, Dennis Hayes, chairman of Hayes Microcomputer, says his modem costs half as much to make as a modem that complies with the V.32 standard, and still performs as well.

While he sympathizes with customers faced with a confusing array of choices, Hayes thinks they are better off than they were last year. "We have more options for the user. . . . The nature of datacommunications is getting more complex. I don't think that means it's getting worse for the consumer," he says.

Still, with dozens of 9,600 bps modems on the market, few of which are entirely compatible, not all modem makers are going to survive. With so much competition, "there's going to be a shakeout in the high-speed dial-up modem market," predicts Telebit's Jordan. A key issue that will determine the fate of the sur-

U.S. modem market

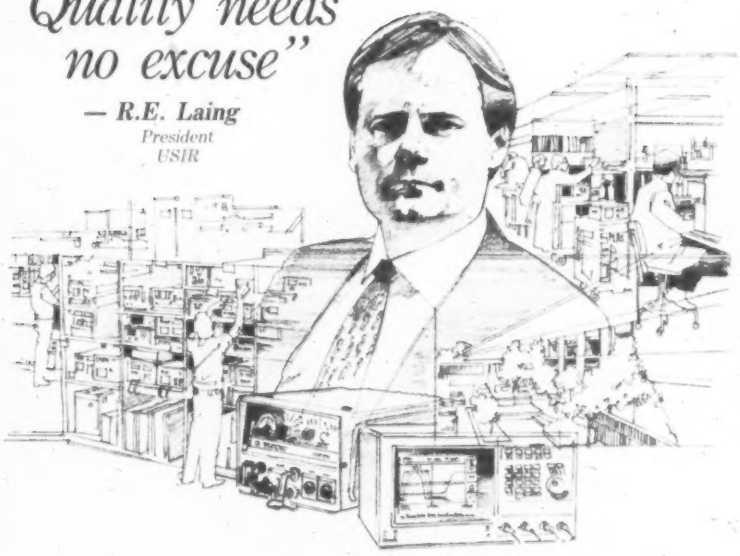


Source: Dataquest Inc.

Growing use of modems with personal computers will drive unit sales of modems up, but rapidly falling prices will cut back the dollar value of the market

"Quality needs no excuse"

— R.E. Laing
President
USIR



"I know the costly problems late-arriving or faulty instruments can cause you.

"That's why I see to it every product you rent, lease, or buy from USIR is quality from the ground up. And shipped on time. Regarding delivery, you have my promise:

If we miss a shipping date, we'll knock 50% off your first month's rental.

And we *keep* you problem-free by stocking ready inventories of the products you need—from the premier names in test instrumentation. And by insisting all USIR calibration complies with MIL-STD-45662.

"We also make renting easy and economical with the broadest package of rent / lease / equity options anywhere.

"At USIR, *quality means quality*, not excuses. Because we want you coming back for all your instrument needs.

"Play it safe. **Rely on US."**

RE Laing

United States Instrument Rentals, Inc.

US
A U.S. Leasing Company
2988 Campus Drive
San Mateo, CA 94403
800-824-2873

vivors is whether the V.32 standard is selected by CCITT. But other issues are more complex.

Some manufacturers have started adding data compression technology to their 2,400 bps modems, kicking up their speed by a factor of two or three while only adding about $100 to the cost. Cynar thinks this may bring problems for 9,600 bps modem makers. A 2,400 bps modem equipped with data compression technology that increases transmission speed three times, to 7,200 bps, is nearly as fast as a 9,600 modem, and less expensive, he says.

MicroCom Inc., for example, has a standard it's pushing, called the MicroCom Network Protocol; Hayes has another data compression technology; and still others are coming on the market. Recently, Adaptive Computer Technologies developed a new faster data compression technology that has received support from a number of modem vendors, according to Cynar of Dataquest. "The market is messy, but it might have gotten even messier now because we have data compression issues," Cynar says.

With dozens of 9,600 bps modems on the market, not all makers are going to survive

Both Hayes and Jordan point out that the same data compression technology can be used on both 2,400 bps modems and 9,600 bps modems —a fact they think mitigates the potential influence data compression schemes may have on their own markets.

Adds C. Kenneth Miller, chairman of Concord Data Systems in Marlborough, Mass.: "I don't see it [data compression] eating into V.32 at all because it makes V.32 run better." Miller believes 9,600 bps modems using the V.32 standard will soon dominate the market because the price of those modems is coming down quickly. "The nonstandard products will end up dying," he says.

"There are still a lot of people buying their first modem out there," comments Cynar. "I think the world is headed toward V.32 . . . but we're not moving too quickly into it." □

IC equipment vendors wise up to economic reality

They must: There are still far too many of them, and IC makers are pruning supplier lists. So the gear firms are going back to what they do best

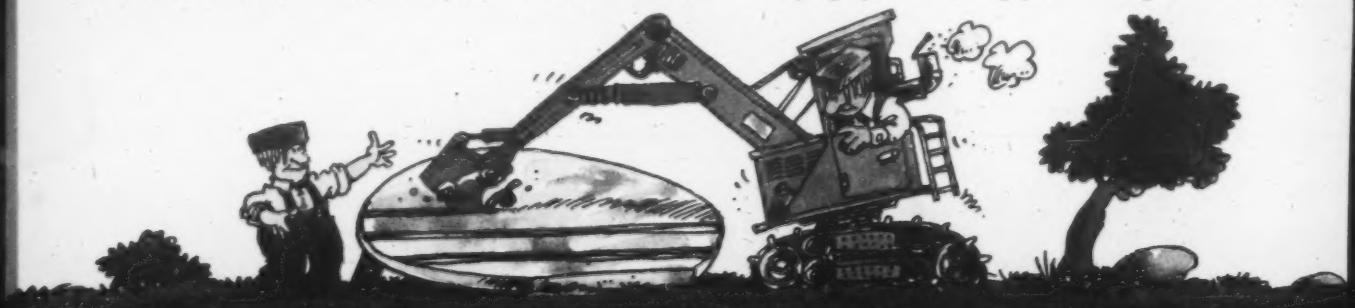
BY MARK MEHLER

After suffering through two years of declining sales and persistent calls from their customers to straighten out their act, suppliers of semiconductor-production equipment — for both front-end processes and back-end assembly — are wising up to a changing industry.

Broad-line vendors, who had overextended themselves in a bid to become virtual one-stop shops, have pared down their operations to concentrate on their mainstream businesses. Decentralization — the watchword of the IC equipment industry, until it got out of hand —has been replaced by an emphasis on consolidation. In short, say observers, the industry is undergoing a painful, but necessary, structural change.

"A number of things have happened," explains Joseph Grenier, a senior industry analyst at San Jose-based research firm Dataquest Inc. "First, the costs of developing systems and supporting and servicing them have grown so large that even the biggest players can't afford to do it all anymore. Second, the amount of investment in equipment is now so huge that capital equipment committees are not willing to go with any supplier that isn't financially secure enough to ensure long-term survival. The major buying criterion today is no longer technology; it's the ability to support your systems in the field."

The pruning of supplier lists that is taking place throughout the elec-



Total worldwide shipments

($ billions)

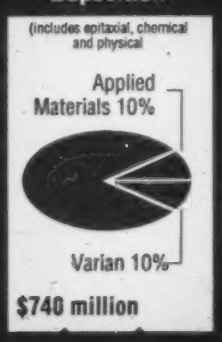
Equipment	1987	1988
Wafer fabrication	$2.71	$3.40
Test and inspection	2.37	2.93
Assembly	0.66	0.78
Total	**$5.74**	**$7.11**

Equipment

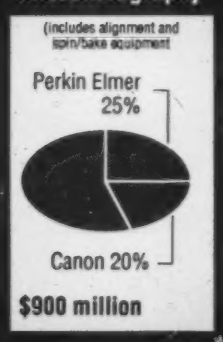
Estimated 1987 worldwide sales
(Worldwide sales are for fiscal 1987)

Semiconductor fabrication

Deposition



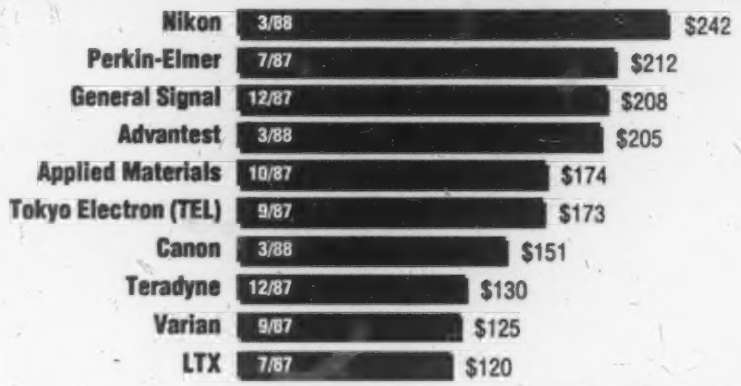
Microlithography



Dry etching

Top semiconductor production equipment makers

Worldwide fiscal year sales ($ millions)



Source: VLSI Research Inc.

tronics industry is occurring with a vengeance in IC equipment. Glen Possley, who heads the die-manufacturing organization at Signetics Corp., says his company no longer wants to deal with multiple vendors of the same equipment. In etching systems, for example, Signetics has narrowed its supplier list to two: Applied Materials Inc., and Lam Research.

"We won't install a piece of prototype equipment in a fab," argues Possley. "We will only buy a proven system from a proven supplier."

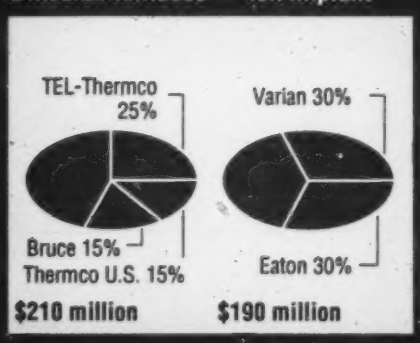
The raw numbers, says analyst Stephen Balog of Shearson Lehman Hutton Inc., simply don't add up. "There are just too many players," he contends. "In etch, figuring in huge sales support overhead and engineering costs of $5 million or $10 million for a new system, you have to be able to produce these [machines] in volume to amortize the cost . . . the industry can't afford 30 or 40 etch suppliers."

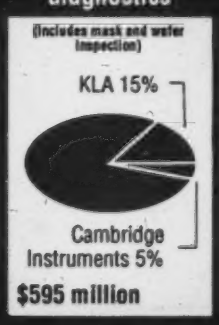
Some examples of how the equipment industry has responded to these realities: Perkin-Elmer Corp., the leading worldwide systems supplier for seven years, before falling to the No. 2 position in 1987, behind Nikon Precision (see accompanying chart), pulled out of its dormant etching and sputtering businesses last year to concentrate strictly on its successful optical and electron-beam lithography operations; General Signal Corp., the No. 3 supplier, has consolidated about 20 different autonomous companies into six divisions, and exited at least three market segments, including photomasks; Varian Associates, the ninth largest supplier, backed out of the etch business; and GCA Corp., which was the leading maker of wafer steppers in the early 1980s until running adrift financially, agreed to merge into General Signal last March.

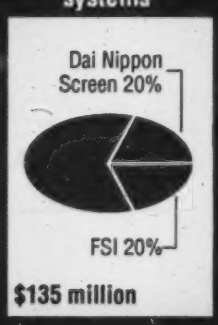
"Life was a lot easier in the 1970s

Jon McIntosh

Major equipment markets and leaders







and early 1980s," sighs David Huchital, vice president of Perkin-Elmer's Connecticut operations, which include optical lithography systems. "Our highly segmented approach to the market was the proper response to serving the individual markets. Now it's a much tougher world out there. We're not going to see another boom year like 1984. Our customers have made enormous strides in increasing utilization of their existing equipment, and we're being hard-pressed on issues like set-up time."

Moving people around

Under PE's new functionally and geographically based organization, Huchital manages the company's analytical instrument business and other Connecticut operations, in addition to lithography. He says this allows the flexibility to shift resources according to market demands. Right now, for example, the instrument business is hot, while the government business is not. "If that changes, I can move people around without having to resort to layoffs," says Huchital. "The corporate goal, which is greater flexibility and quicker response, fits perfectly into the requirements of doing business [in the IC equipment industry]." PE last year posted about $212 million in IC equipment sales, about two-thirds of its revenue in 1985, according to research firm VLSI Research Inc.

Pruning of supplier lists is occurring with a vengeance

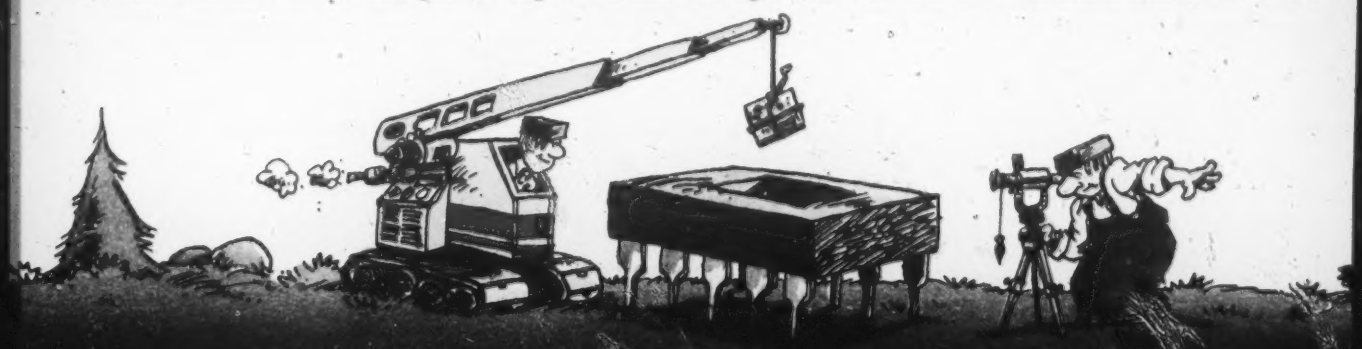
Jack Halter, senior vice president for operations of General Signal's Technology Industries Sector, which includes semiconductor equipment, explains his company's recent consolidation as an effort to become the No. 1 or No. 2 player in each of its target markets. Halter agrees that the days of the marginal vendor — as anything other than the so-called "walking dead" — are numbered. He adds that the acquisition of GCA, which augments the company's existing Ultratech Stepper business, should catapult GS into a leadership role in both direct image, called 1:1; and image reduction, such as 5:1 and 10:1; steppers.

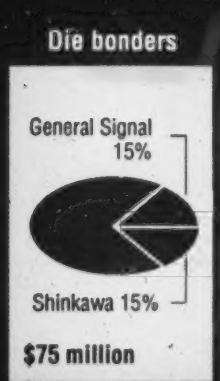
Breaking even

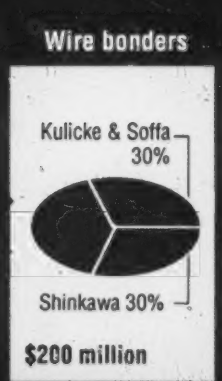
Nevertheless, even for those suppliers that already hold leadership positions in more than one market, profitability is not assured. Applied Materials Inc., which is the leading supplier of etching, chemical-vapor deposition and epitaxial reactor equipment, only broke even last year after losing money in two quarters, notes chairman James Morgan. Morgan attributes the disappointing earnings to the expense of rushing the newest CVD system to market.

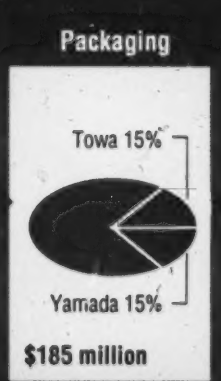
As for the industry's near-term outlook, VLSI Research's president G. Daniel Hutcheson sees worldwide

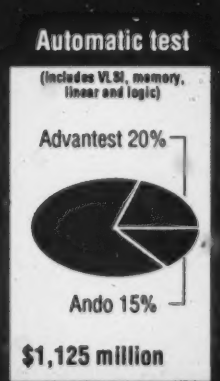
Jon McIntosh

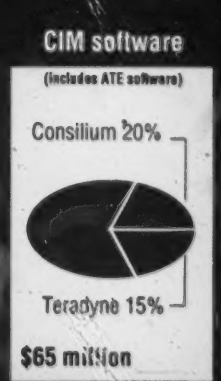












shipments rising for the second straight year. After sliding to $5.03 billion in 1986, shipments rose to $5.7 billion last year and will reach $7.1 billion this year, says Hutcheson. The researcher attributes most of that expected growth to skyrocketing demand from Japan for new DRAM capacity, and to rising sales in Europe, Korea and other foreign markets. In Taiwan alone, he says, 13 IC companies have started up in the past year.

U.S. merchant IC makers, however, remain "afraid" of another recession next year, says Hutcheson. Should they begin loosening their purse strings, he believes, "our projections will go through the roof."

Signetics' Possley, in fact, already sees U.S. chip makers getting serious about bringing on new fabs over the next two years. He says Signetics will spend $100 million on capital equipment this year, more than twice as much as it spent in 1987. "I see people like Texas Instruments and Motorola anxious to bring on new capacity," he says. □

Semiconductor materials market

Worldwide market ($ millions)

Semiconductor fabrication materials	1987	1988	1989
Silicon and other substrates	$1,380	$1,789	$2,039
Photomasks	885	995	1,134
Resists, Positive	103	125	142
Negative	71	86	98
Advanced	5	6	7
Wet chemicals	258	379	431
Gases	467	519	591
Deposition materials	173	203	231
Total fab materials	**$3,342**	**$4,102**	**$4,673**
Semiconductor packaging materials	**1987**	**1988**	**1989**
Leadframes	$728	$970	$1,077
Ceramic packages, metalized	499	665	742
Encapsulation resins	309	412	493
Cerdip	288	384	389
Headers, cans and lids	186	290	320
Thick film pastes	206	220	242
Multichip substrates and packages	174	215	237
Die attach materials, bonding wire	300	384	445
Other materials	146	175	210
Total packaging materials	**$2,636**	**$3,715**	**$4,155**
Total semiconductor materials	**$6,178**	**$7,817**	**$8,828**

Source: Rose Associates

Chip-making software: Still waiting for the big time

Back in 1984, few businesses looked as promising as the emerging market for software packages to run semiconductor fabrication plants. Every major integrated circuit supplier had automation on the brain, and such software functions as controlling the flow of work-in-process and scheduling equipment maintenance were seen as crucial to that effort. Then, in 1985, the IC industry turned down, and continued down for two years.

"It goes almost without saying that in a deep recession like the last one, the first thing to go is the automation plan," says Peggy Marie Wood, who follows the manufacturing software sector for market researcher Dataquest Inc. "Everyone agrees that what the [software houses] offer is marvelous, and absolutely essential to automating a fab, but very few customers can justify a long-term investment when the bigger issue is survival."

The current size of the market is difficult to determine, however, as the industry tends to report sales by installation. Some IC facilities employ a range of software modules; others use only one or two. Analysts estimate 1987 U.S. industry volume at no more than $25 million, virtually all of it shared by two California-based companies: Consilium Inc. of Mountain View, and Promis Systems Inc. of Santa Clara. Consilium is believed to have a base of about 180 to 200 installations and Promis about 60 to 80 sites. Hewlett-Packard Co., which backed out of the market a few years ago in the belief that it would not support an expensive product development effort, continues to service its roughly 95 existing installations. Two newer players, Cameo Systems, which has picked up a few sites, and Qronos Technology Inc., which has yet to install its first commercial system, are trying to work their way into the market.

In the past 12 to 18 months, Consilium and Promis have moved aggressively to broaden their bases outside the IC market, selling software modules into the printed circuit board, aerospace and pharmaceutical industries. George Kellar, director of corporate development at Consilium, says diversification is a key to the company's strategy, but he insists its bedrock semiconductor-related business is alive and well. In addition to strong offshore sales, says Kellar, major U.S. customers are finally discovering that automation is no luxury.

Meanwhile, no matter what the current state of the market, the potential is vast. Maria Ligeti, the president of Qronos, which offers an IBM-based system featuring fault-tolerant transaction processing for quicker response time, points out that fewer than 25% of the world's IC plants have installed any commercial software package. "It's a huge empty market we're hoping to fill," says Ligeti, who believes that the market could reach $750 million by 1993.

The picture sharpens for U.S. cable equipment manufacturers

As the cable television industry penetrates more households, demand for converters and other gear intensifies

BY DEBBIE NARROD

Last year proved to be a banner year for cable television equipment suppliers — the best since the early '80s — and most manufacturers expect 1988 to be strong too, as cable system operators continue to upgrade and rebuild their systems.

Senior analyst Steve Rosenberg of Paul Kagan Associates (PKA), a research and investment firm in Carmel, Calif., believes, in fact, that 1988 will be one of its biggest years for construction ever. "There's no doubt [about it]," he says. "All the projects are in the pipeline."

He's projecting a $2.6 billion market for cable construction in 1988, up 12% to 13% from 1987's $2.3 billion. Those figures include not just electronics equipment, but also coaxial cable, labor and design. But it's obvious that the electronics segment also will be very strong.

John Donohue, president of Oak Communications Inc., says 5 million to 5.5 million "addressable" in-home TV set-top cable boxes, or converters, will be sold this year, about the same number as last year. "Addressable" units are cable signal descramblers that can be given messages — or addressed — from a cable operator's central computer to allow certain channels to be viewed, or scrambled, in the subscriber's home.

"Plain" converters, without fancy electronics and incapable of allowing a change in viewable channels without a visit from the cable company, will sell in the range of 4 million units in 1988, about even with '87, according to Oak's projections; and up from between 2.5 million and 3 million in 1985.

Driving the growth are several factors. The cable industry has been consolidating drastically in the past few years, with operators buying one another out at an incredible pace. "The new owners are driven by their cash flow projections to add services and increase cash flow," points out PKA's Rosenberg.

Eugene Mopsick

General Instrument's Krisbergh: "The trick is to make the customer perceive the converter as an added value, by offering pay-per-view"

Impulsive viewing

Addressable converters, especially those capable of what the industry calls impulse pay-per-view (IPPV) which allow a cable subscriber to punch in a few numbers on his box and then see a special show or movie, and be billed later, is one way to increase revenue.

Executives at American Television and Communications Corp. (ATC) in Denver, and Continental Cablevision Inc. of Boston — the No. 2 and No. 3 cable operators, respectively — estimated systems serving half of their subscribers were addressable-capable. Included in that number are also subscribers with the necessary computer equipment at the systems' headends. Headends are the individual system's headquarters facility, which receives TV and satellite signals; changes them to different fre-

quencies for cable distribution of signals; and begins the distribution process.

"We will roll out a substantial number of addressable PPV homes in 1988," says Continental vice president Rob Stengel, who adds that "virtually 100%" of Continental's operations — including those of soon-to-be-acquired American Cablesystems Corp. — are rebuilt and upgraded. "In a lot of those systems we will be going addressable."

Home shopping, which can also use the IPPV technology, is another growth area, and operators and manufacturers alike are expecting the day to come when banking and other transactional deals can be done through the cable converter box rather than outside the home.

Operators are also replacing distribution — TV signal carrying — electronics with newer models. ATC vice president for engineering and technology James Chiddix points out that the technology has advanced a great deal over the past three years. "The cables put in place five years ago carrying 30 channels can be pushed to 40 to 50 channels [with the new equipment]," he says.

Steven Necessary, Scientific-Atlanta Inc. (SA) marketing manager, broadband communications, says he believes that while cable operators are looking to spend the same in 1988 as they did in 1987, more of the money will go to distribution upgrades, using the newly developed amplifiers. Amplifiers are electronic devices used to increase the strength of a TV signal; they are placed along distribution cable often enough so that a good signal is maintained.

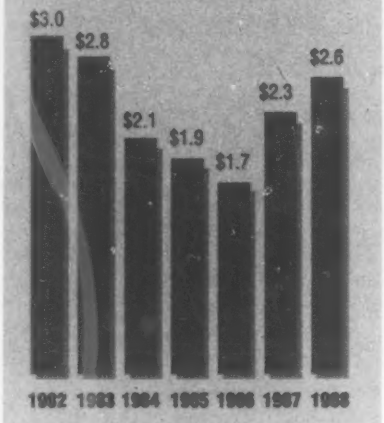
Some of the new amplifiers and equipment allow old cable that offered 30 channels of service to be upgraded, offering 35 or 40 more channels. This is called increasing the bandwidth of the cable, and a lot of operators are simply adding the new distribution equipment to do this, getting more subscriber money for more channels offered.

Addressing addressability

While the distribution equipment is new, addressable technology is not. Denver-based Tele-Communications Inc. (TCI), the nation's largest cable operator, went "extensively into addressability in 1983," according to Dave Willis, director of engineering.

Cable TV construction market

U.S. market for electronics equipment, coaxial cable, labor and design ($ billions)



Source: Paul Kagan Associates

The cable TV construction market is almost back to the level of the early '80s

But for addressability without IPPV capability, he notes, "there's diminishing demand as more customers take advantage of cable-ready TV sets."

Such sets were designed by TV manufacturers to eliminate the set-top converter box from the cable company, allowing the cable signals to feed into the TV — because of adequate large-channel capacity — straight from the coaxial cable. But addressable systems scramble or encrypt each signal so that, from the central facility, the cable company controls the headend, which signals what a customer receives. Customers with cable-ready sets in an area where the cable company has addressable equipment will have to have a converter box anyway.

The cable industry has been consolidating drastically in the past few years

"The trick is to make the customer perceive the converter as an added value, by offering pay-per-view," says Hal Krisbergh, vice president and general manager of the Hatboro, Pennsylvania-based Jerrold Division of General Instrument Corp. "It's a perspective issue."

"Pay-per-view (PPV) has been a promise, a gleam in the industry's eye for a number of years," says SA's Necessary, "and the quantity and quality of programming is finally to the point where the promise is being fulfilled."

General Instrument and SA are the leaders in cable equipment manufacturing, holding about 75% of the market, says Robert Anastasi, analyst with the Robinson Humphrey Company Inc. in Atlanta. GI, he says, has about 50% of the market and SA about a quarter.

GI uses a custom VLSI chip in its boxes, Krisbergh says, claiming a product that is "world class in terms of sophistication." He points out, however, that the converter box is only part of a system that depends on an intensive amount of hardware in the headend. The headend not only has equipment to move signals from satellite-transmitted frequencies to cable distribution frequencies, but also computers to handle addressable functions and control functions, allowing for changes in the channels a subscriber receives, as well as for billing those changes properly.

Historically, Krisbergh comments, the idea of a two-way transmission failed because of the complexity and cost of the set up, such as AT&T's videotex system, Viewtron. "The key is the memory space in the security system," Krisbergh says, to be able to store PPV information in the box and pull it out at a later time. "To store isn't complex," he says. "But to pull in information from 100,000 boxes is."

GI and others have developed affordable technology for this, of late, and at the same time program services have begun to make PPV offering movies and special events desirable. "There's why the industry is so excited," Krisbergh says.

General Instruments saw sales grow to $100 million in 1987, Krisbergh says, up 60% to 70% from 1986. The company is expecting about the same this year, a seeming flatness he says "belies the fact addressability is growing significantly," because last year's sales included a large movement of "plain" converters as operators restructured channel

offerings after a change in federal laws.

SA's Necessary wouldn't project what his firm is expecting for 1988. The company's first quarter report, for the period ending Oct. 2, 1987, says that new orders were up 21%, and analyst Anastasi says the report understates the company's strength.

Pioneer Communications of America Inc. shipped a record 850,000 converter boxes last year, according to marketing manager Mike Hayashi, and expects to move about the same number this year. Slightly more than half of last year's units were addressable.

Zenith Electronics Corp. saw cable business up 20% in 1987 over 1986 and expects to meet 1987's figures this year, according to Vito Brugliera, vice president for marketing and product planning. Zenith cable products. Brugliera cites a "renewed interest in addressable converters" as a reason for the growth, as well as for some new products. Some of the proprietary electronics in Zenith's equipment are made in-house and others are contracted with outside vendors.

Oak is hoping for a 20% increase in revenue this year over last, Donohue says. "The industry has been hot. Cable built 26% more miles of cable distribution in 1987 than in 1986," he points out.

"Substantially more activity is planned," he continues, pointing to the last of the new systems getting started, to consolidations requiring rebuilds as systems transfer hands, and to an improved market for home terminals.

An innovation on the horizon for cable TV is the use of fiber-optic cable

Oak's most sophisticated line is its Sigma addressable converter, the only box, Donohue says, that uses encrypted audio as part of its security.

"The industry is looking for features," Donohue comments. "They would like the box to go away, but that's impossible."

Instead, he says, the box must be friendly both to consumers and cable operators.

Trade groups National Cable Television Association and Electronics Industry Association have developed what they're calling the IS-15 or Multiport, to help solve the problem, notes NCTA vice president of science and technology, Wendall Bailey. The Multiport combines the tuner, power supply, remote and electric cord common to one's TV set, VCR and converter box. Placed in a TV set, it eliminates interface problems when a cable operator has compatible equipment. Pioneer is looking at using the IS-15, Hayashi says, and Bailey says RCA Corp. and Panasonic are among manufacturers using it in TV sets. None of those companies are manufacturing the equipment for the standard.

Because of the incompatibility between cable-ready TV sets and VCR addressable cable boxes, a number of manufacturers are offering what's called "off-premise" equipment — not electronic — that avoids the issue altogether because signals are trapped or untrapped outside the home. But pay-per-view is limited. TCI has put off-premise equipment in a few large systems, but TCI's Willis says it's possible TCI may eventually upgrade the box to addressability. "We'll keep the options open," he says. "We haven't yet seen a huge success in PPV, but it may be there, and if it is, we want to take advantage of it."

One more innovation on the horizon for cable is the use of fiber-optic cable, which to date has been costly and problematic. "There are deep technical problems in going totally analog," observes Willis. But operators are trying it. ATC is working on a system that would use existing coaxial cable in small pieces served by a fiber-optic backbone, says Chiddix. "The key is the breakthrough on cost and perfection of analog transmission." While some in the industry say the clearer signal offered by fiber-optics would reduce the number of amplifiers used by cable companies, Chiddix said the way ATC is looking at using fiber-optics, few electronics would be eliminated. □

What New England region surpassed its projections for new business development by 75%?
NORTHERN RHODE ISLAND
We've got it right here.
Northern Rhode Island Marketing Council, Inc.
P.O. Box 371, Lincoln, RI 02865 Call: (401) 722-3400 or (401) 762-1730

Singapore's plan to offer more than cheap assembly

Singapore now wants to attract more sophisticated development work. Deals with National and Sierra Semi are a good start

In the late 1960s, Singapore's economy was faltering. British investors were pulling up stakes as Singapore prepared for independence. Making matters worse, baby boomers hit the streets looking for jobs at a time when unemployment was running at about 20%. "We were hit with a double whammy," says Liow Voon Kheong, head of the Electronic Components Group of Singapore's Economic Development Board (EDB).

Singapore's government moved fast to attract foreign manufacturers. "Back then, we just wanted employment for our people," says the EDB head. U.S. firms quickly moved in. Fairchild Semiconductor Corp., National Semiconductor Corp. and Texas Instruments Inc., for example, set up shop and brought with them thousands of assembly-line jobs. "When you industrialize from scratch, you have to make use of foreign investment to grow," says Philip Yeo, EDB chairman, interviewed at the Board's Singapore office.

Singapore not only survived the transition from a British colony to an independent nation. It thrived and even overcame a serious recession from 1982 to 1985. Focusing on electronics, Singapore lured millions of dollars in foreign investment. As a result, unemployment today is less than 5%.

Now, says Yeo, Singapore is embarking on a new economic development strategy. No longer content with just attracting assembly-line jobs, the EDB is focusing on luring more sophisticated development work to the country. "We're in a much better position to attract more value-added manufacturing," says Yeo, who wants to expand research and development and engineering work in his country.

"Providing low-cost labor was only a short-term solution, according to Yeo. "There will always be countries that offer cheaper labor," he explains. The long-term winners, he continues, will be those countries that provide a solid infrastructure, efficient workers and flexible financing. And, Yeo stresses, Singapore intends to be a long-term winner.

Singapore swing: From British outpost to thriving economics powerhouse inside 30 years

Comstock, Inc.

Toward that end, Singapore Technology Corp. Ltd. (STC) — a diverse group of companies created with government investment — in November announced the formation of Chartered Semiconductor Ltd. Chartered Semiconductor, a joint venture of STC, Sierra Semiconductor Corp. and National Semiconductor, will fabricate and test state-of-the-art CMOS application-specific integrated circuits. Chartered Semiconductor will invest $40 million in the wafer fabrication plant and an additional unspecified amount more for equipment. "It's a coup for Singapore and a coup for us," says James Diller, Sierra president.

Owned 74% by STC; 17% by Sierra; and 9% by National, the joint venture will be the first operation in Singapore capable of designing and fabricating CMOS chips. Also planned is a design center where circuit designers will develop standard products and ASIC design services for Asia.

Three-tech trio

When Chartered Semiconductor's planned facility comes on stream early next year, production capacity will be 5,000 6-inch wafers per month, with the potential to double capacity in the future. Chartered Semiconductor, to be based in Singapore Science Park, is expected to generate about $50 million a year in sales. In the early stages, more than half of production will be sold to the three partners — a solid underpinning for the venture.

"This will be our major manufacturing facility," says Sierra's Diller. "Well over half our products will come from there in the forseeable future." Ed Pausa, National Semiconductor vice president for international manufacturing, says the joint venture will "satisfy a number of National's needs and interests," including expanded chip-making capacity without significant additional capital investment as well as access to improved process technology.

Production will be based on Sierra's Triple Technology CMOS process, which permits integration of three technologies: analog, digital and nonvolatile (electrically erasable) memory all on the same chip. National shares the technology, which both U.S. firms say is ideal for very large-scale integration chips applica-

WHEN THERE
WILL BE
NO LONELINESS,
NO DESTITUTION,
NO SICKNESS,
NO WAR,
ONLY THEN
WILL THERE
BE NO NEED
FOR THE
AMERICAN
RED CROSS.

Contact your local chapter.

American Red Cross

ble for a wide variety of niche markets with high growth potential.

STC concurs. "Through our strategic partnering with Sierra and National — which provide advanced technology and market access — we are able to create a commercially viable semiconductor business," says Lim Ming Soong, STC deputy chairman. STC had been searching for new technologies to complement and strengthen its traditional defense and industrial electronics businesses. Yeo, who serves as chairman of STC as well as EDB, says the formation of Chartered Semiconductor is the latest in Singapore's continuing efforts "to position our country at the forefront of technology."

Yeo points out that Chartered Semiconductor will create new jobs for engineers and technicians. The firm is expected to employ 260 workers by the end of next year, 40% of which will be technical engineering personnel. "This is consistent with our continuing efforts to provide more and more highly skilled and sophisticated employment opportunities for Singaporeans," says Yeo. Meanwhile, some 55 Singapore engineers will be trained at Sierra and National's U.S. facilities this year.

Partner power

STC had been looking for an American partner for integrated circuits since 1985, when it hired a consultant to find an appropriate company. The consultant screened 15 relatively small firms, finally recommending Sierra — with the provision that a larger company with big buying power be brought in as a third partner and customer. National Semiconductor seemed a likely choice. Since Sierra's inception in early 1984, Sierra and National have had many technology agreements and business transactions. Furthermore, Sierra president Diller was National Semiconductor's managing director for Southeast Asia (based in Singapore) from 1973 to 1975. National has had a production facility in Singapore for almost 20 years. STC and Sierra, meanwhile, have had a close working relationship for the past two years. STC has invested in Sierra and served on its board of directors.

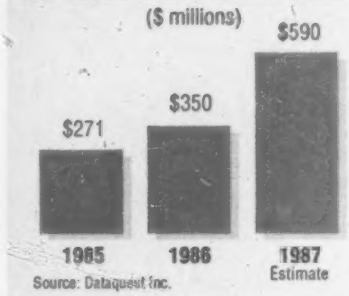
Chartered Semiconductor's production capacity will be 5,000 6-inch wafers per month

Donald Valentine, Sierra chairman and senior partner of Sequoia Capital, a Menlo Park, Calif., venture capital firm, helped arrange the deal. For several years, Valentine has been working with Singapore's economic officials to invest the country's money in high-technology ventures. "Singapore is interested in expanding its technology base to increasingly higher levels," he says. Chartered Semiconductor is an example of the government's desire to expand Singapore's technological base and acquire new markets as well. "The real thrust of EDB and the government is to do exactly what has been done with Chartered Semiconductor," says Valentine.

Though Singapore's political leaders have been known to keep tight reins on various enterprises, business partners give government agencies high marks for letting foreign firms run their business without interference. Government officials, for their part, contend that they try to keep out of publicly funded ventures — even if it's necessary to prop up a failing business. "Companies must live or die as commercial ventures," says Lim. "The government's interest is only as a shareholder."

BETH KARLIN

Singapore's semiconductor consumption



Source: Dataquest Inc.

Singapore's goal of becoming an R&D and engineering center means more local production of advanced chips — and more chip consumption

Computer companies are back to their growing ways

After a brief hiccup in 1986, computer production again outpaces all industry. Even without AI's help

Maybe the world is becoming a little safer for artificial intelligence. There was never any question that this technology has a bright future ahead, only when that future will come. As is usually the case with new technologies that manage to cast a glint in investors' eyes as soon as they come out of the laboratory, AI was oversold. It simply had to wait for enough software developers to generate applications which enough people could use. The first such program appeared this year, according to *The New York Times* and industry newsletters *Expert Systems Strategies* and *RELease 1.0*.

Timed for the season that ended this past April 15, it was an expert tax preparation program that runs on IBM or compatible personal computers. Fortunately for the AI field, it was not only a good expert system but also a finely crafted and friendly program that drew the top rating from *Business Week* magazine's review of income tax software.

Ironically, AI pioneer Symbolics Inc. had no taxes to pay during this season. The leading developer of Lisp machines — computers specialized for the development of expert systems with the Lisp language — incurred massive losses last year, even as its sales doubled from the previous year. This, after five years of more than doubling sales every year and placing seventh among ELECTRONIC BUSINESS' fastest growing companies.

Even though Symbolics is deemed representative of the AI field, its problems are not. Quite the contrary. All AI companies have known that, for AI to expand its market, the expert systems it generates must run on low-cost personal computers or workstations. But, as developers have become more proficient in this technology, they have learned to do the development also in general-purpose personal computers or workstations. These not only cost less than Lisp machines, but can also be used for other applications.

Like Symbolics, Compaq doubled its sales last year. But, unlike Symbolics, Compaq was very profitable, and its profits more than tripled. Besides, Compaq is a much larger company — its sales exceeded $1.2 billion this year, and show every sign of doubling again in 1988. The same can be said about workstation leader Sun Microsystems Inc. ELECTRONIC BUSINESS ranked this company as the fastest growing among computer and electronics companies, based on average growth over the period from 1982-1987. Little of these companies' growth came from AI applications, but they can look to AI as a source of growth for the next five years, even if few users care about a product's roots in AI, only that it is a good program.

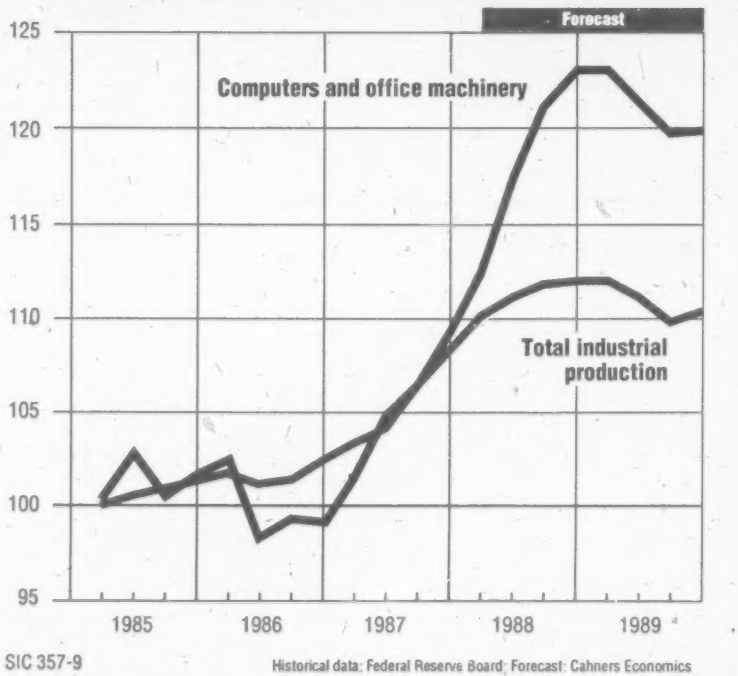
The production of companies such as Compaq, Sun Microsystems and Symbolics, contributes to what the Federal Reserve Board measures as the industrial production index for SIC 357-9, for "computer and office machinery." This index, which traditionally has grown faster than the country's overall index of industrial production, faltered in 1986 when it declined for the first time even as the overall industrial activity kept growing. Fortunately, SIC 357-9 is back to its winning ways. It increased by 6% in 1987, as opposed to the respectable 4% for all industry, and Cahners Economics expects the relative growth of computer production to accelerate with 12%, versus 5% for all industry in 1988.

Moreover, says senior economist Elizabeth Baatz, the value added by computer manufacturing in the United States may already account for 6.5% of the value added by all industries. This is likely to increase as AI gets to the public, even after the tax season is over.

ALBERTO SOCOLOVSKY

Computers and office machinery production index

Quarterly averages, 1st quarter 1985 = 100, seasonally adjusted



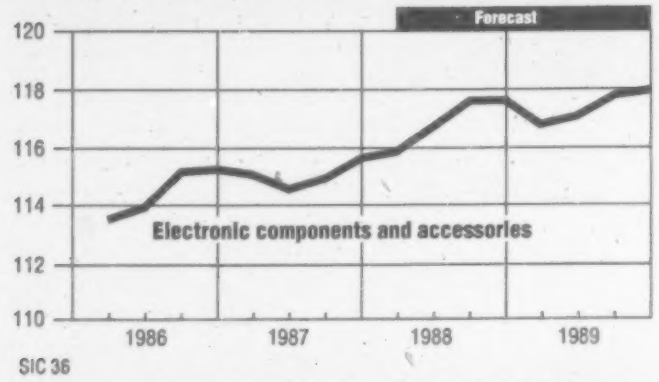
SIC 357-9

Historical data: Federal Reserve Board; Forecast: Cahners Economics

PPI Active components — May 15

Producer price index — Electronic components

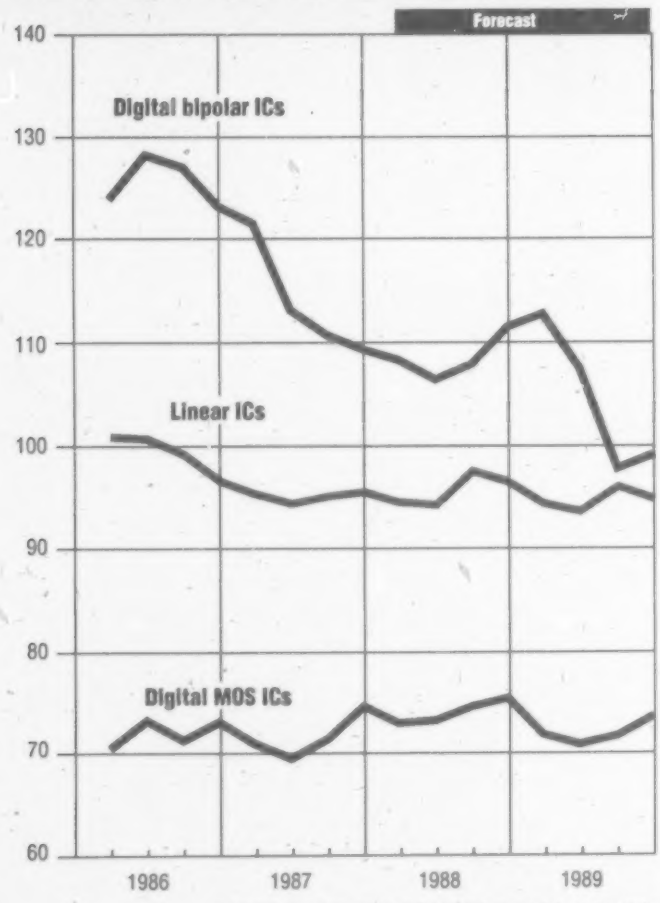
Quarterly averages, 1st quarter 1982 = 100



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Producer price indexes — Active components

Quarterly averages, 1st quarter 1982 = 100



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Calm market holds price increases to minimum

Supply and demand conditions for most electronic components remained on an even keel in the first quarter of 1988. The Bureau of Labor Statistics reports that producer prices of electronic components rose 1.4% in the first three months of the year compared with the year-ago period. Prices are rising, compared with a 0.2% components inflation rate in the last quarter of 1987.

Still, the U.S. electronics industry recovery will soon be entering its third year and supplies remain fairly abundant by past standards. Capacity constraints, except for advanced submicron components, are rare.

Electronics Purchasing's survey of buyers shows leadtimes — the length of time between placement of an order and delivery — stretching only one or two weeks above last year.

Cahners Economics expects leadtimes to be peaking by this summer. But compared with 1984, leadtimes will not be a significant problem. For instance, leadtimes for digital ICs, at nearly seven weeks in March 1988, will top out at nine weeks this summer, far below the 22-week leadtime seen back in 1984.

The comparative calm in these markets will hold price increases to a minimum for digital bipolar, digital MOS and linear ICs. Digital bipolar producer prices slipped 10.6% in the first quarter of 1988 compared with early 1987. These prices are expected to end the year 4.5% below 1987.

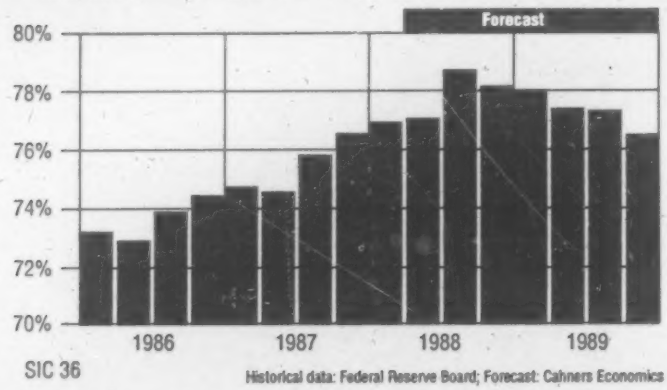
Producer prices for digital MOS rose 4.0% in early 1988, increasing from the 0.6% gain seen in 1987. Price increases for these products will most likely hold in the 4% to 5% range.

Linear IC prices fell 0.7% early this year. The deflationary trend was more severe in 1987. By the end of 1988, linear IC prices are expected to have risen slightly above 1987 levels.

Plant utiliz — May15

Plant utilization — Electrical machinery

Average percentage of capacity utilized per quarter, seasonally adjusted

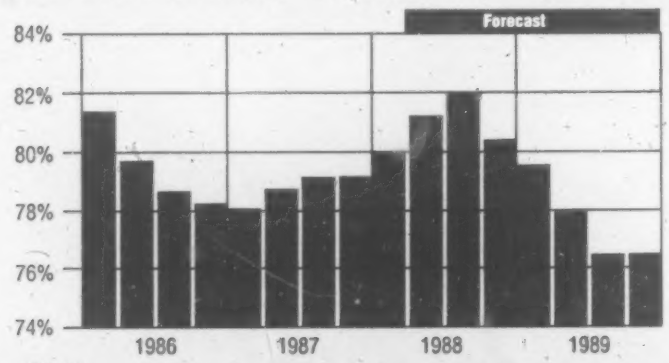


SIC 36

Historical data: Federal Reserve Board; Forecast: Cahners Economics

Plant utilization — Instruments

Average percentage of capacity utilized per quarter, seasonally adjusted

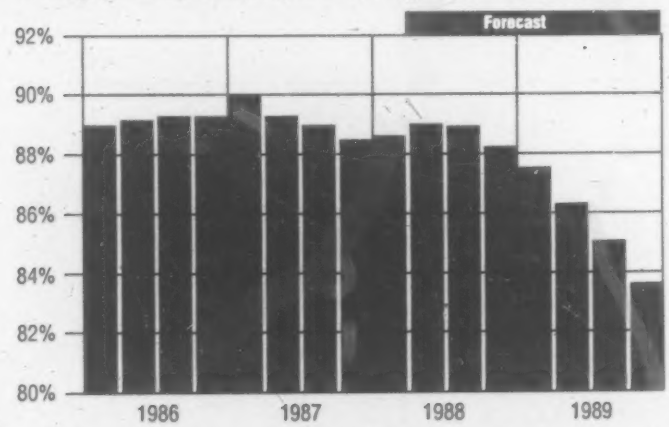


SIC 38

Historical data: Federal Reserve Board; Forecast: Cahners Economics

Plant utilization — Aerospace

Average percentage of capacity utilized per quarter, seasonally adjusted



SIC 37

Historical data: Federal Reserve Board; Forecast: Cahners Economics

Survey suggests increase in capacity utilization

Manufacturing capacity is on the rise. Rising merchandise exports, increasing productivity in the manufacturing sector, and a generally strong domestic economy are starting to put pressure on U.S. industrial capacity.

Process industries like paper and chemicals are under the most pressure from lack of excess capacity. These industries contributed to an increase in the percent of capacity utilized in manufacturing facilities from 79.6% at the beginning of 1987 to 82.5% by the end of last year. The last time utilization rates were this high was in early 1980. And the last time they increased this much was in 1983.

The electronics and electrical machinery industry is still operating at 76.6% of capacity. At the beginning of 1987, capacity utilization stood at 75%. Although the Commerce Department doesn't break out the electronics industry in their survey, evidence from *Electronics Purchasing's* survey of electronics manufacturers suggests capacity constraints in the electronics industry are tighter. But neither the Commerce Department's survey of electronic/electrical industries, nor *Electronics Purchasing's* survey of electronics manufacturers have shown a steep rise in capacity utilized over the past 12 months.

Until early 1988, the instruments industry seemed to be following in the sedate path of the electrical machinery industry. From January to December 1987, the instruments capacity utilization rate rose less than one percentage point. Then, from 78.1% capacity utilized in December 1987, factory utilization rose to 80.4% in February 1988.

Meanwhile, the aerospace industry experience has been vastly different. With defense dollars pouring in, capacity utilization at aerospace plants hit 90% in March 1987. The last time this industry saw such a high utilization rate was in 1980, and then the rate was still only 87%. The trend now for aerospace: with production headed down, utilization rates are sure to follow suit.

Back on track

The value of new orders and shipments for computers and office machinery skyrocketed in January from their fourth-quarter doldrums.

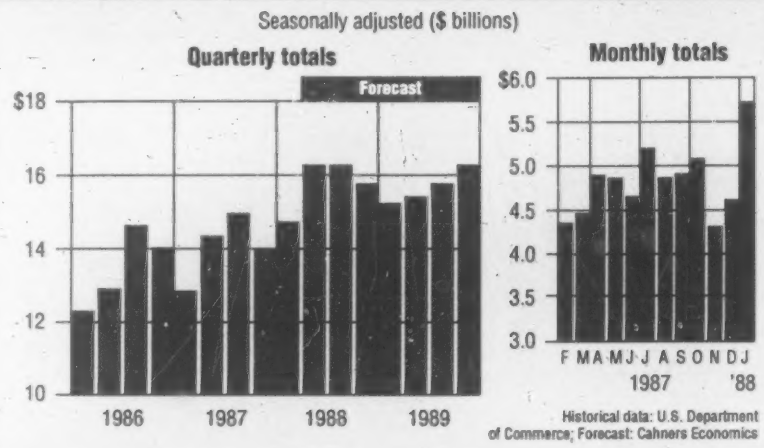
New orders came in at $5.69 billion, a 24.2% increase from December 1987 and the highest monthly level since February 1985.

January shipments totaled $5.67 billion, a 17.6% increase from December and the highest monthly level ever recorded on a seasonally adjusted basis.

The month-to-month double-digit surge for new orders and shipments is a correction to the panic reaction in November when new orders plummeted 15% and shipments toppled 13%. The healthy rebound now gets the computer industry recovery back on track.

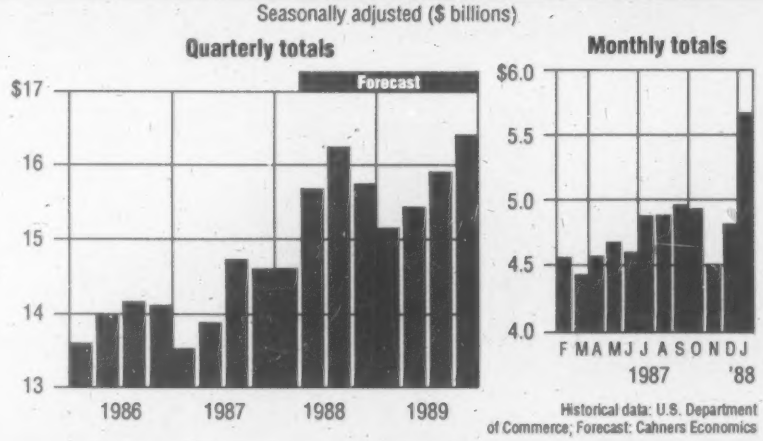
The monthly trade figures for December brought the year-end 1987 value of computers and office machinery exports to $18.7 billion, 21% greater than the value in 1986. Imports grew 26% in 1987 to total $19 billion.

Computers and office machinery — New orders



Historical data: U.S. Department of Commerce; Forecast: Cahners Economics

Computers and office machinery — Shipments



Historical data: U.S. Department of Commerce; Forecast: Cahners Economics

Computer market database

	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, January)	302.4	299.20	+1.07%	265.7	+13.81%	330.0	+9.13%
Shipments (SA, $ millions, January)	$5,668	$4,818	+17.64%	$4,532	+25.07%	$5,050	-10.91%
New orders (SA, $ millions, January)	$5,690	$4,582	+24.18%	$4,072	+39.73%	$5,071	-10.88%
Unfilled orders (SA, $ millions, January)	$18,902	$18,680	+1.19%	$18,769	+0.71%	$20,062	+6.14%
Inventory-to-shipment ratio (SA, January)	1.76	2.06	—	2.16	—	2.13	—
All employees (thousands, January)	468.2	470.1	-0.40%	457.9%	+2.25%	489.2	+4.49%
Production workers (thousands, January)	153.1	153.7	-0.39%	149.5	+2.41%	157.6	+2.96%
Exports ($ millions, December)	$1,869	$1,884	-0.76%	$1,451	+28.81%	$1,798	-3.81%
Imports ($ millions, December)	$1,903	$1,784	+6.65%	$1,259	+51.14%	$1,775	-6.69%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics